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A MONTHLY MAGAZINE DEVOTED TO THE USEFUL APPLICATION OF COMPRESSED AIR.

VOL. IX. NEW YORK, DECEMBER, 1904. No. 10.

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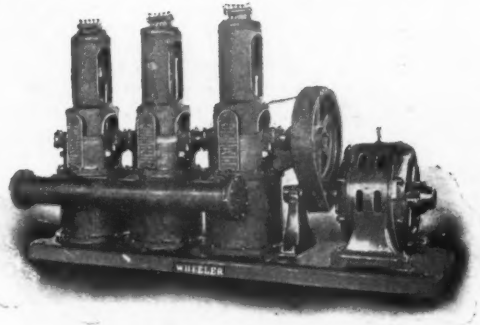

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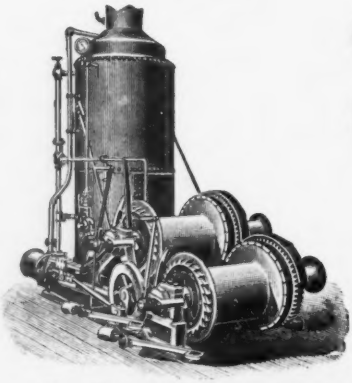

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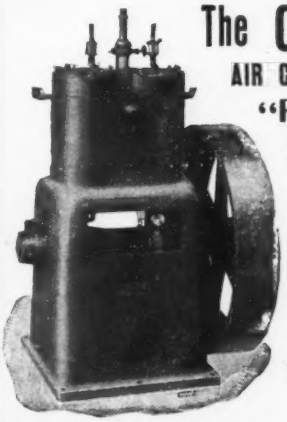

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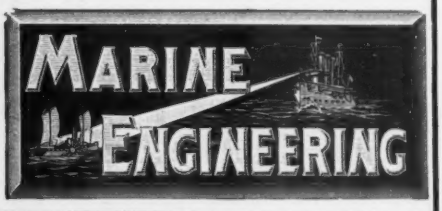
Compressed Air,
26 Cortlandt Street,
New York City, N. Y.

My Dear Mr. Saunders:—I must congratulate you on the very excellent work "Compressed Air Information" and I hope the engineering public will appreciate it to the extent that it will remunerate you for the care and attention you must have devoted to the book in order to present the information contained in so useful a manner.

I find it contains all necessary information upon Compressed Air subjects contemporary with its publication. I use it for reference, and on more than one occasion it has rendered me substantial benefits worth many times its price. I wish you all success.

Very truly yours,
E. A. RIX.



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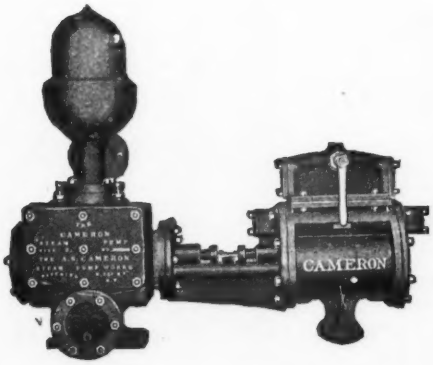

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VOL. IX. DECEMBER, 1904. NO. 10

Compressed Air and the New York Subway.

Public attention has been directed to the New York Subway. Its opening on October 27 was made the occasion for general rejoicing. Its operation is an important factor in solving the transportation problem for New York. The construction of this elaborate system of tunnels introduced engineering problems never before encountered. It was a new thing to build what might be termed an underground city at the water's edge and through a mass of solid rock. The network of pipes and conduits below the surface made the task still more difficult. Despite all these obstacles the work has been done. It is well to note that this has been made possible through the agency of compressed air.

Steam and electricity may have their particular uses in the broad field of rock excavation; but, under the conditions which existed in the construction of the subway, compressed air proved most suited in a majority of cases to serve as the form of power required. In both tunneling and "cut and cover" operations compressed air was used almost exclusively to operate the rock drills. It also served to work the pumps which kept the excavations free from water. While there was nothing novel about these uses of the air, they were significant on account of the important part played in one of the greatest engineering feats of the century.

While the completion of the subway has reduced the congestion on the transit systems of New York for the time being, the rapid growth of the city and its suburbs threatens to bring about a return of the old conditions. This means an enlargement of the underground transit system, further construction along similar lines, and the utilization of compressed air for other and even greater tasks.

As the tunnels are built under the city, other tunnels are stretching out to the surrounding neighbors of the greater city, and in their construction compressed air has figured as importantly as in the others. What it has done in subaqueous tunneling has already been dwelt upon at length. These facts serve to show the remarkable part that this form of power has played and will continue to play in providing New York with proper transportation facilities.

Advertising.

Considerable interest was shown in the advertising contest which was conducted by COMPRESSED AIR at the request of the Ingersoll-Sergeant Drill Company, and which came to an end November 1. Many suggestions were received, some of which were excellent. The awards in this contest will be announced in the January number of COMPRESSED AIR.

The importance of attractive advertising even in the mechanical field cannot be overestimated. Intelligent use of advertising space is the secret of successful periodical advertising. COMPRESSED AIR is at all times glad to advise its advertisers as to the character of their advertising, with a view to making it as effective as possible. It is just as much to the advantage of COMPRESSED AIR as to its advertisers that their advertising should be effective.

The New York Subway Under the East River.*

The New York Subway, now practically completed from the City Hall north, is not confined to Manhattan and the Bronx, but extends under the East River to Brooklyn. At the present time interest centres in the latter division, officially known as Contract No. 2. This part of the work is being built by the Rapid Transit Subway Construction Company, the contract price being $2,000,000 for construction and $1,000,000 for terminals. It joins the present subway at Ann street and Broadway, New York, and passes thence under Broadway to Bowling Green; under Battery Park, Sate street and the East River to Brooklyn, where it runs under Joralemon street to Fulton, and under the latter and Flatbush avenue to the intersection of Atlantic. The length of main line is 3.1 miles, which, with the loop at South Ferry, 0.4 mile long, gives a total length of line of 3½ miles, containing 8 miles of track. The tubes under the river are about 2,800 feet in length between the pier lines.

On shore the work will be carried forward by tunneling under the streets, openings being formed at suitable points for the removal of excavated material and the passage of supplies. The work at Battery Park, including the loop, is all open cut, as shown in the accompanying half-tones, Figures 2, 3, 4 and 5, all of which were taken a short time ago at this section. Figure 1 shows a map of the work at the Manhattan end and the direction from which the views in Figures 2, 3, 4 and 5 were taken. Under the river for about half the distance from the New York shore the material encountered is rock. The remainder passes through sand, gravel and bowlders, a mixture much more treacherous and difficult to work than the silt composing the bed of the Hudson River, through which the old Hudson River tunnel has been constructed and through which the Pennsylvania Railroad is now building a pair of tubes.

A section of a typical tunnel built on shore is shown in Figure 6. This is the usual steel-concrete design, such as was employed in the previous work. Each tunnel is 13 feet wide and 13 feet high from the base of the rails. The first layer of the floor is concrete, 8 inches thick, upon which is placed water proofing. Upon this is laid concrete up to the ties. The side walls are of brick and terra cotta. The panels are about 5 feet between centres and between the columns are spring centres of concrete to form the roof.

The sections beneath the river are very similar to those used by the engineers of the Pennsylvania tunnel and which have been described in the previous issues. These are also shown in Figures 7 and 8. In both designs the tunnel is circular in section and 15½ feet clear diameter. In soft material the circle is formed of ribbed and flanged cast-iron plates, the end and side surfaces of which are machined to insure tight joints. After being placed in position these are lined with

*A description of the compressed air plant for this tunnel was given in COMPRESSED AIR for December, 1903.

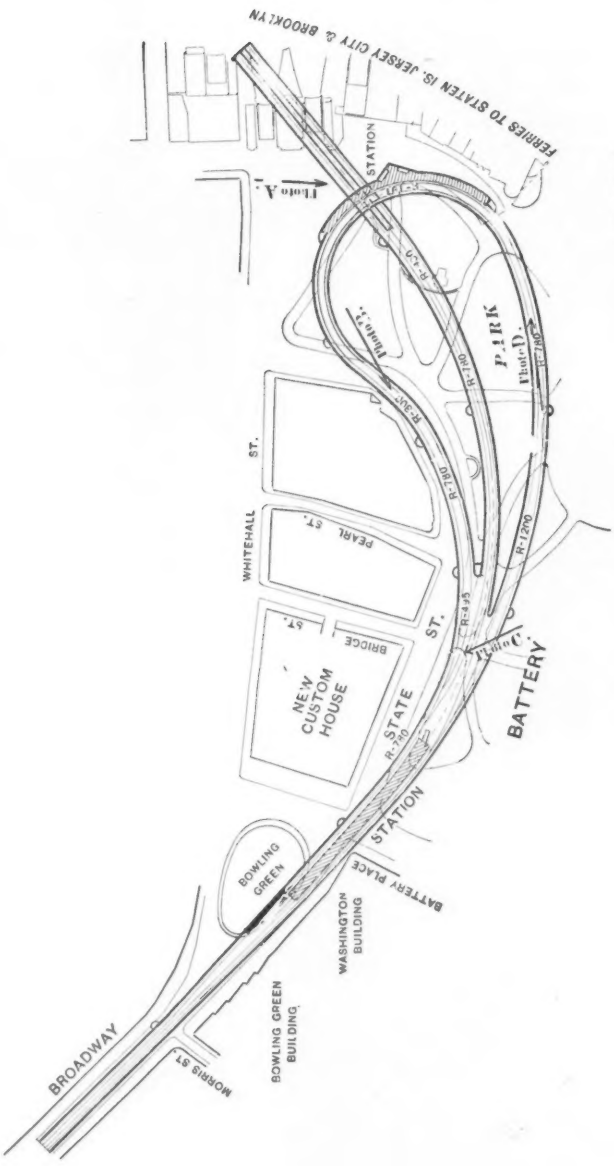


FIG. 1.—MAP OF NEW YORK SUBWAY AT BATTERY PARK. ARROWS INDICATE THE DIRECTION FROM WHICH THE ACCOMPANYING VIEWS WERE TAKEN.

FIG. 2—PHOTO "A." EXCAVATION AT SOUTHERN PART OF LOOP. MATERIAL IS LIFTED BY THE CABLEWAY AND CARRIED TO THE TRESTLE, AND FROM THERE IT IS WHEELED TO THE SCOWS.

FIG. 3—PHOTO "B." ILLUSTRATING METHOD OF SUPPORTING TROLLEY ON STATE STREET.

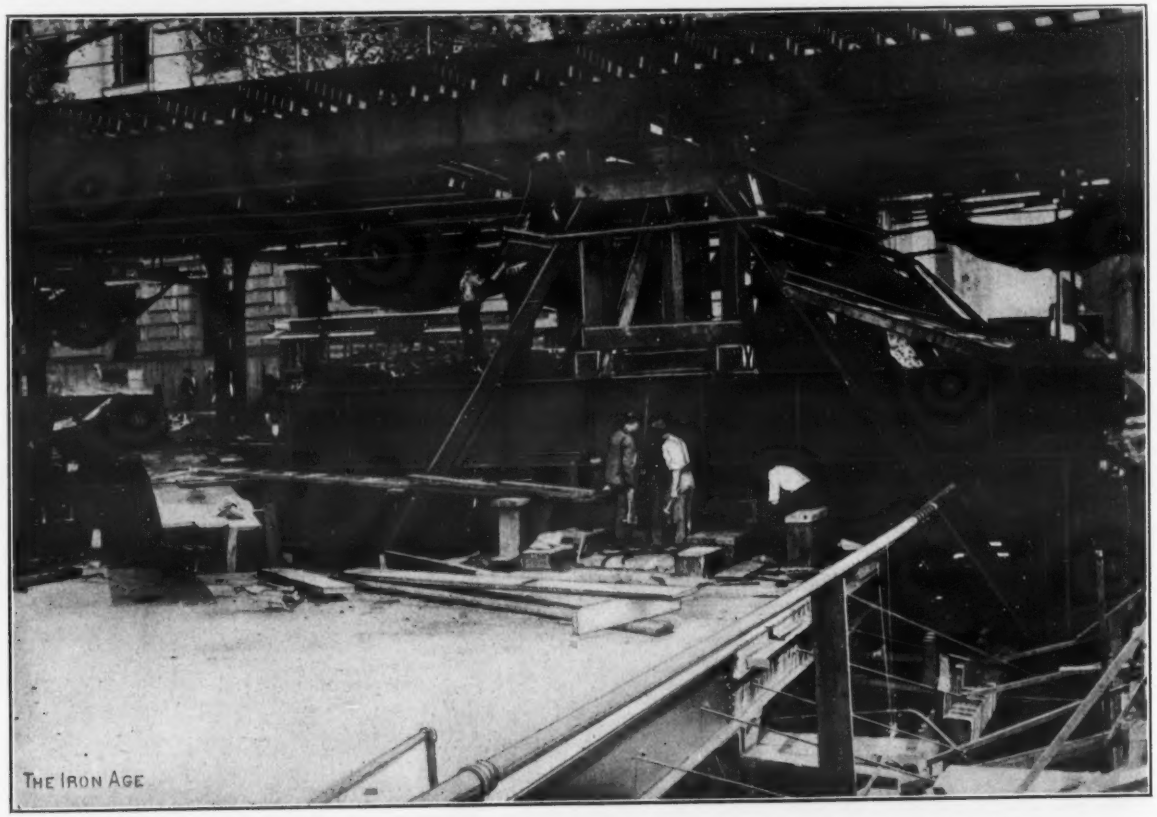


FIG. 4—PHOTO "C." SHOWING METHOD OF SUPPORTING ELEVATED ROAD DURING CONSTRUCTION OF SUBWAY AND NEW FOUNDATIONS FOR COLUMNS ON SUBWAY ROOF. THE COMPLETED ROOF OF THE SUBWAY MAY BE SEEN IN THE LEFT FOREGROUND.

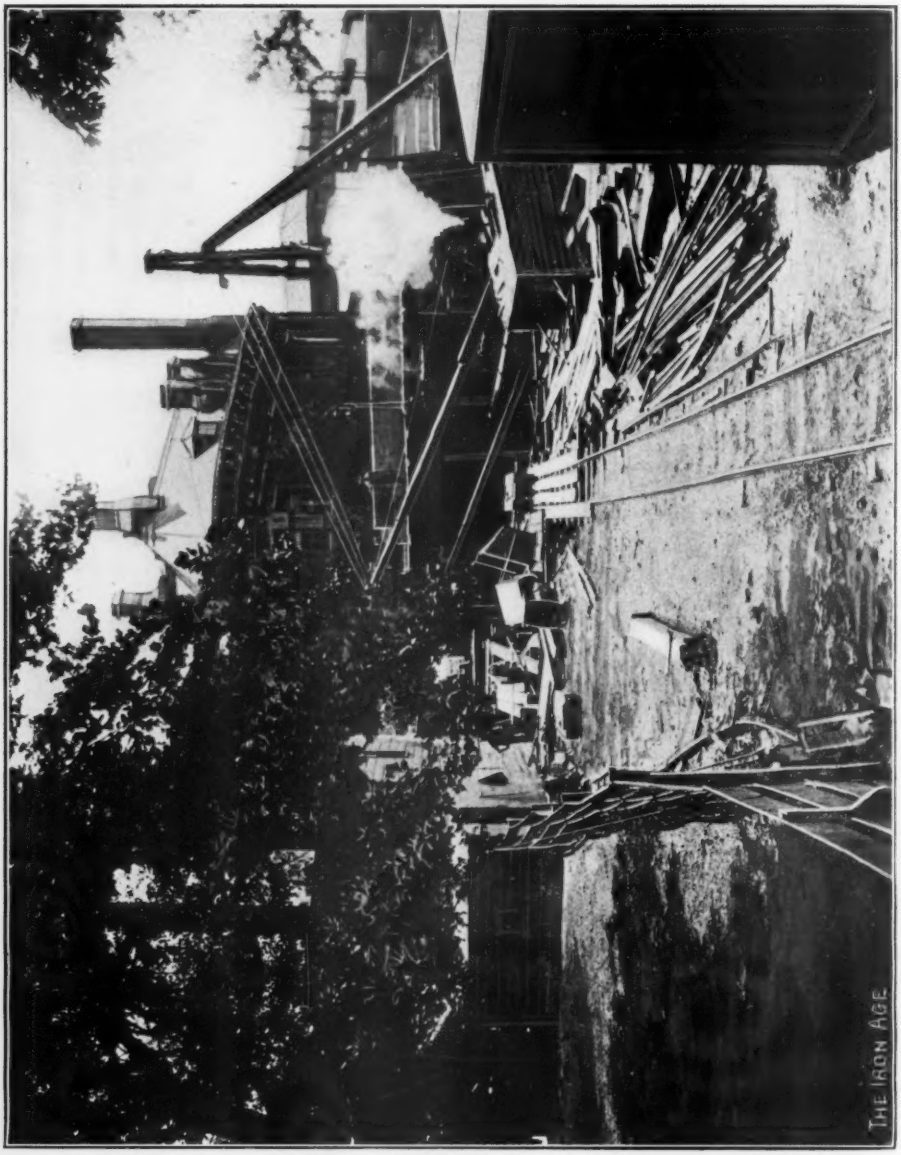


FIG. 5—PHOTO "D." VIEW LOOKING SOUTH TOWARD THE BARGE OFFICE. EXCAVATED MATERIAL FROM THE RIVER SECTION IS RECEIVED HERE, LIFTED TO TRESTLE AND TAKEN TO SCOWS.

beton flush with the ribs. Nine segments form the circle.

The construction is entirely different through rock, as shown in Figure 8. The metallic part of the tube is there formed of 5-16-inch steel plates, reinforced longitudinally by six lines of 4 x 3 x ⅜-inch angles arranged in pairs. Grout is rammed between the outside of this shell and the irregular spaces of the rock. Finally, in the inside, is placed a lining of concrete 15 inches thick.

To carry forward the shore section openings were made in the street at Fulton street, Trinity Church and the small triangular plot made by the intersection of Broadway and Whitehall street. These are the only entrances to the tunnel, and through them pass all supplies and materials. Actual digging is performed step by step in both directions, the sides and roof being supported by struts and beams as fast as openings are made. At Battery Park the open cut method is pursued, sheet piling being used at the sides. The open cut at the southern end is provided with an overhead cableway, which lifts the excavated material to a trestle extending to the Battery sea wall, where it is emptied into a scow, which takes it to the dumping ground. The same disposition is made of refuse from the river section.

An interesting problem was the supporting of the elevated railroad at points where it crossed the subway. How this was done will be understood from the sketch, Figure 9, and the view shown in Figure 4. After the excavation had been carried to the required depth between the elevated columns vertical timbers were inserted and properly braced. Upon these were placed four heavy plate girders. At the elevated columns embraced by these girders a timber framing was put in to transfer the load of the tracks from the columns to the girders. Afterward the column foundations were removed and were rebuilt upon the roof of the tunnel.

Under the river the compressed air system is followed. A shield, identical in general design with those which have been described in connection with the Hudson River and Pennsylvania tunnels, is used. This is a circular shell, slightly larger than the outside diameter of the tube and provided with compartments, which serve as a seal against the escape of air or the entrance of water, and yet

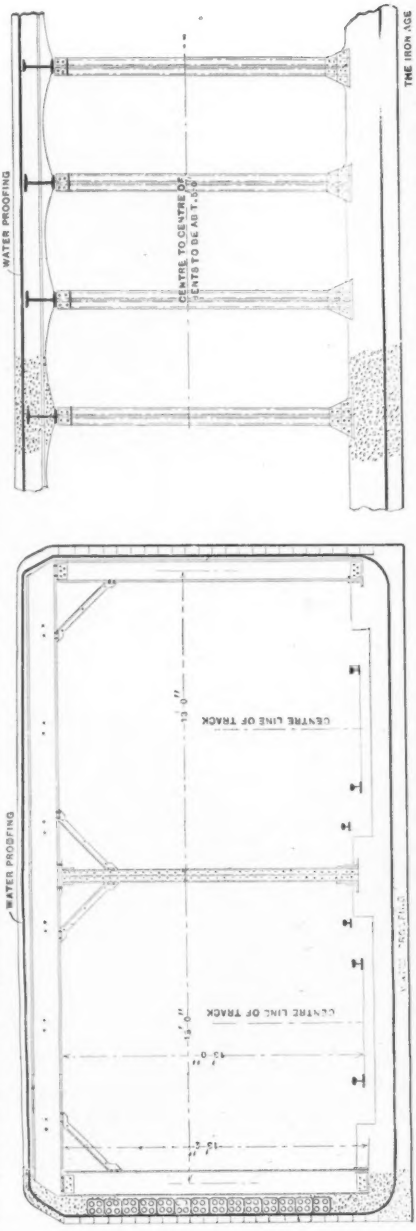

WATER PROOFING
CENTRE TO CENTRE OF CENTS TO BE AB T. 5'0"
THE IRON AGE
WATER PROOFING
CENTRE LINE OF TRACK
CENTRE LINE OF TRACK

FIG. 6—CROSS SECTION AND LONGITUDINAL SECTION OF TYPICAL STEEL-CONCRETE TUNNEL, SHORE DIVISION.

FIG. 5—PHOTO "D." VIEW LOOKING SOUTH TOWARD THE BARGE OFFICE. TAKEN FROM THE RIVER SECTION IS RECEIVED HERE, LIFTED TO TRESTLE AND TAKEN TO SCOWS.

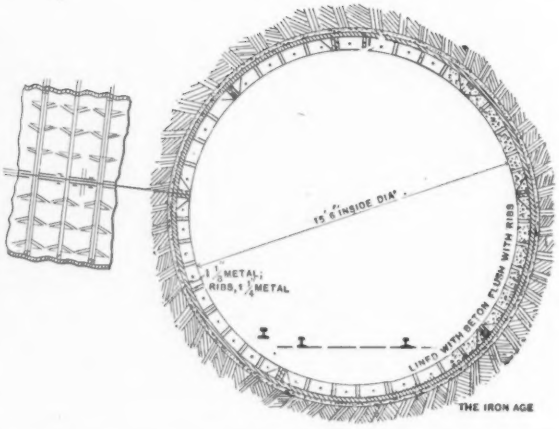


FIG. 7—SECTION OF RIVER TUNNEL IN SOFT MATERIAL. CAST-IRON SHELL.

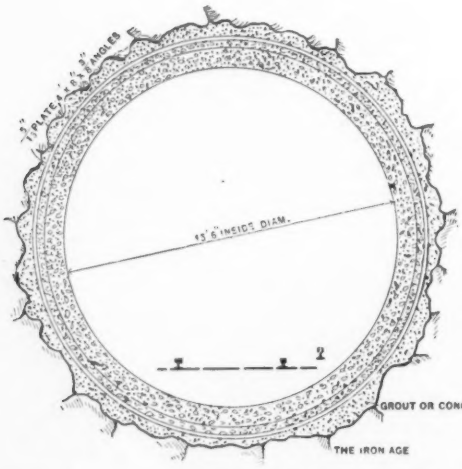


FIG. 8—SECTION OF RIVER TUNNEL IN ROCK. WROUGHT-STEEL SHELL.

at the same time permit the work of excavating to be carried forward. Hydraulic jacks push this shield into the heading, and as fast as it advances plates are inserted to form the tube. This method is safe and rapid—the speed, of course, depending upon the nature of the material met — and therefore economical. — *Iron Age.*

is the Torpedo Baby Drill. It is primarily distinguished from other forms of rock drills by its valve system, which consists of two Corliss valves moved by levers and a tappet actuated by the moving piston. This Corliss valve system as applied to rock drills is the invention of Mr. A. D. Foote, superintendent of the North Star Mines, Grass Valley, Cal. Its mechanical

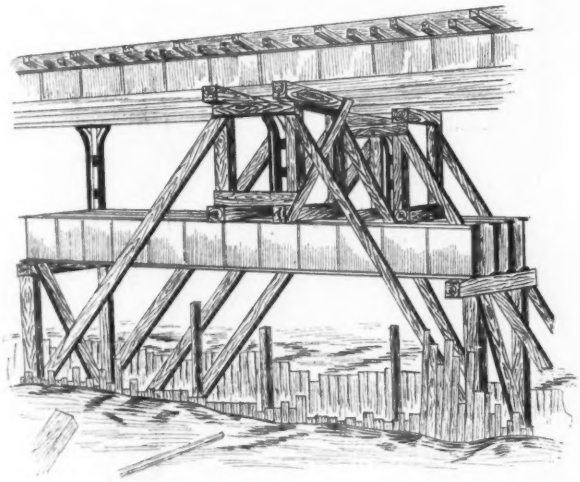


FIG. 9—SKETCH ILLUSTRATING THE METHOD OF SUPPORTING ELEVATED STRUCTURE WHILE EXCAVATING.

Study of the Torpedo Drill.*

The development of machinery for drilling rock represents an evolution and progress through successive stages to the present conditions. This development has been largely the result of practical experience which invariably has pointed out the defects and imperfections of the machines as constructed. Consequently the successful rock-drilling machine of to-day is the result of many unsuccessful attempts to build a machine that would economically drill hard rock under the adverse conditions to which it is subjected by the miner.

One of the latest of these developments

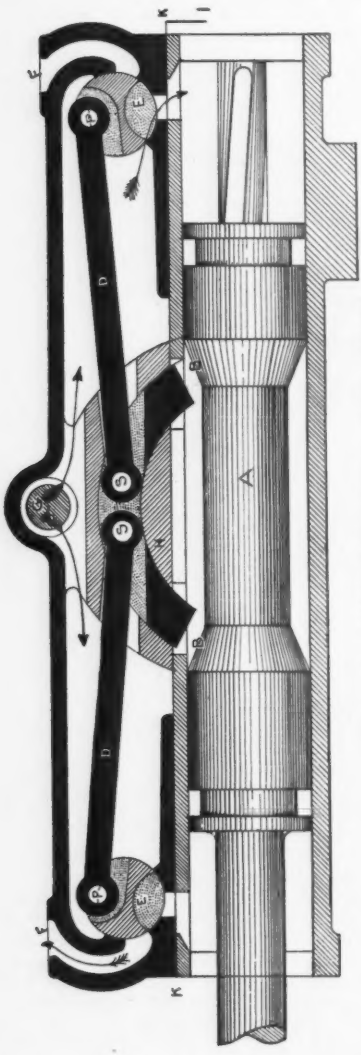
perfection is largely due to the manufacturer, Mr. E. A. Rix.

When tried underground, it was found that this drill did relatively more work, under the same conditions, than did drills of other makes. The object of this thesis was to determine the *absolute* amount of work done by this drill under varying conditions, and as far as possible, to determine the most advantageous condition for its operation. This object was accomplished, and its success suggests the value of a similar set of experiments carried on with other drills. In hopes that they might be of some advantage in such work we describe the methods and apparatus employed, insomuch as they are the results of so many unsuccessful attempts to make the desired measurements.

The actual experiments were preceded by a detailed study of the methods of turn-

*Graduation thesis of A. M. Halloran and F. M. Hamilton at the University of California, May, 1904. Illustrations published through the courtesy of the Rix Compressed Air & Drill Co.

ing out the parts and putting them together. This gives a thorough understanding of the mechanism and its operation.



CUT NO. 1.—SECTION OF TORPEDO VALVE CHEST.

The Torpedo Baby Drill was designed to overcome the loss of air pressure occurring in the ordinary standard rock drill, on account of whose length of port 20 to 40 per cent. of the air pressure furnished by the hose is not received by the piston.

Its construction and operation can be understood from the accompanying cut, No. 1.

The piston *A* impinges on a circular rocker operating within the valve chest and held in position by the bronze guide *H*. To the rocker are attached the two valve rods *DD*, which are attached to the Corliss valves *EE* by the pins *PP*. When the inclined surfaces *BB* on the piston come in contact with the ends of the rocker they slide it in its seat and cause the valve to open and close. The air is admitted into the valve chest at the opening *G* and passes through the open ports into the drill at either end, thereby driving the drill backward and forward.

WEIGHTS AND DIMENSIONS.

Diameter of cylinder, 2½ inches.
Longest practical stroke, 4¾ inches.
Shortest practical stroke, 1¾ inches.
Weight of machine, 120 pounds.

Following is the plan of work adopted in the study:

1. To determine the number of blows that the drill would strike per minute with different lengths of stroke and different pressures.

2. To determine the air consumption of the drill under corresponding conditions as in the first series of tests.

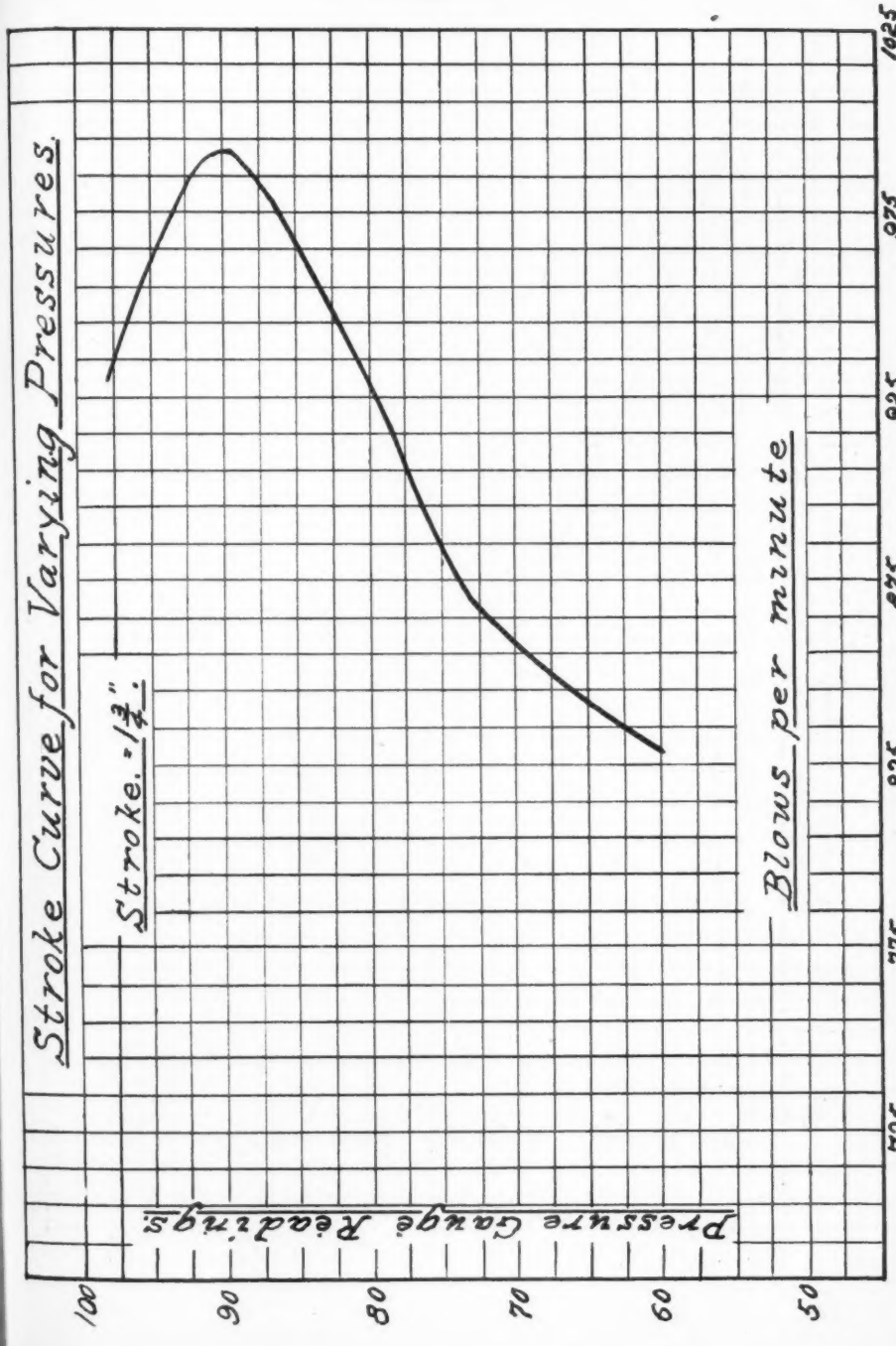
3. To experimentally determine the force of the blow struck by the drill.

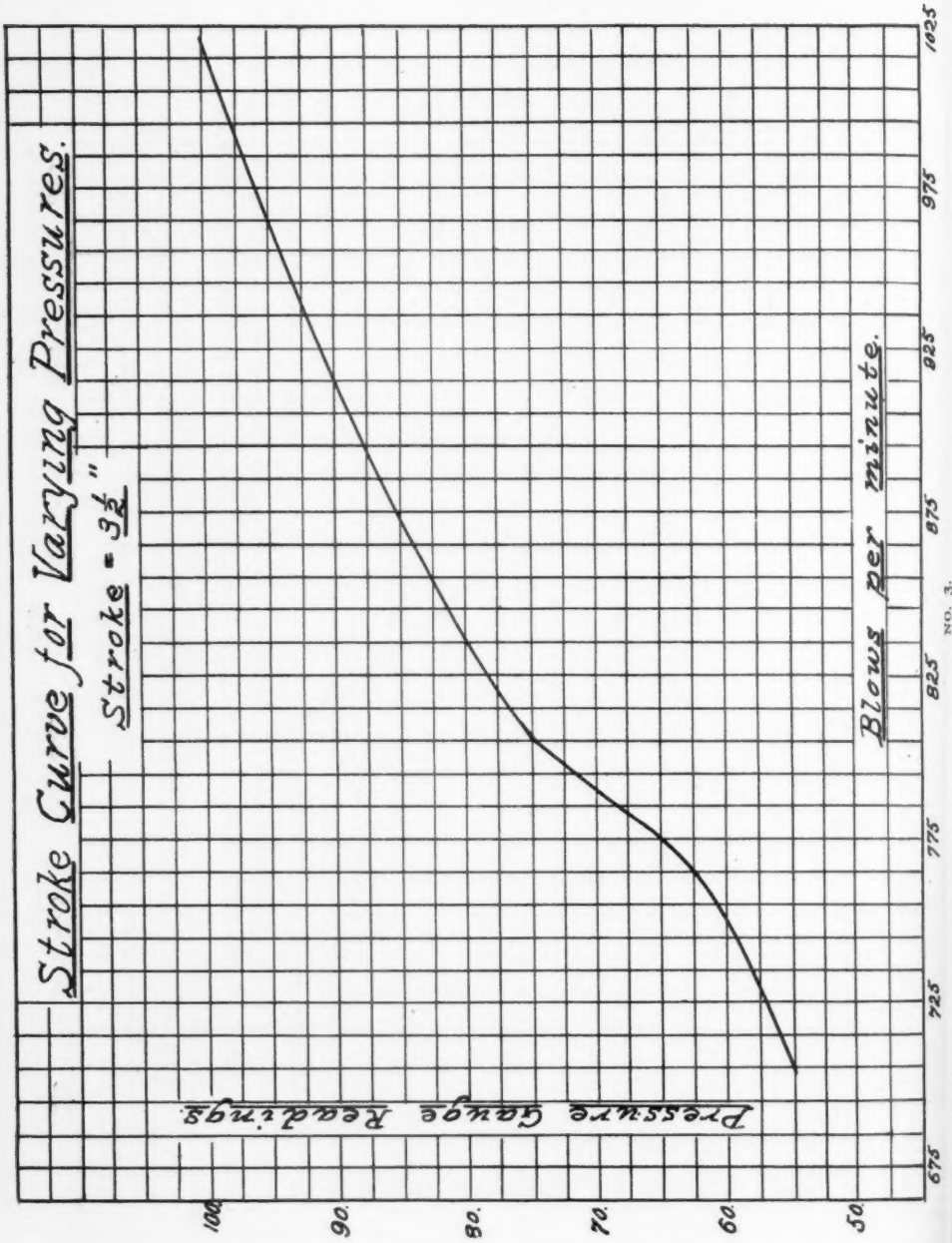
It may be well to state that the methods employed in these determinations are original and used for the first time with this machine, as all attempts to find accounts of similar tests proved unavailing.

1. Determination of number of blows per minute.

The first plan suggested to determine the number of blows that the drill would strike in a given time was to rig a bicycle cyclometer so as to register the number of times that the tappet attached to the drill passed a certain place. This proved impracticable on account of the rapidity and force of the movement.

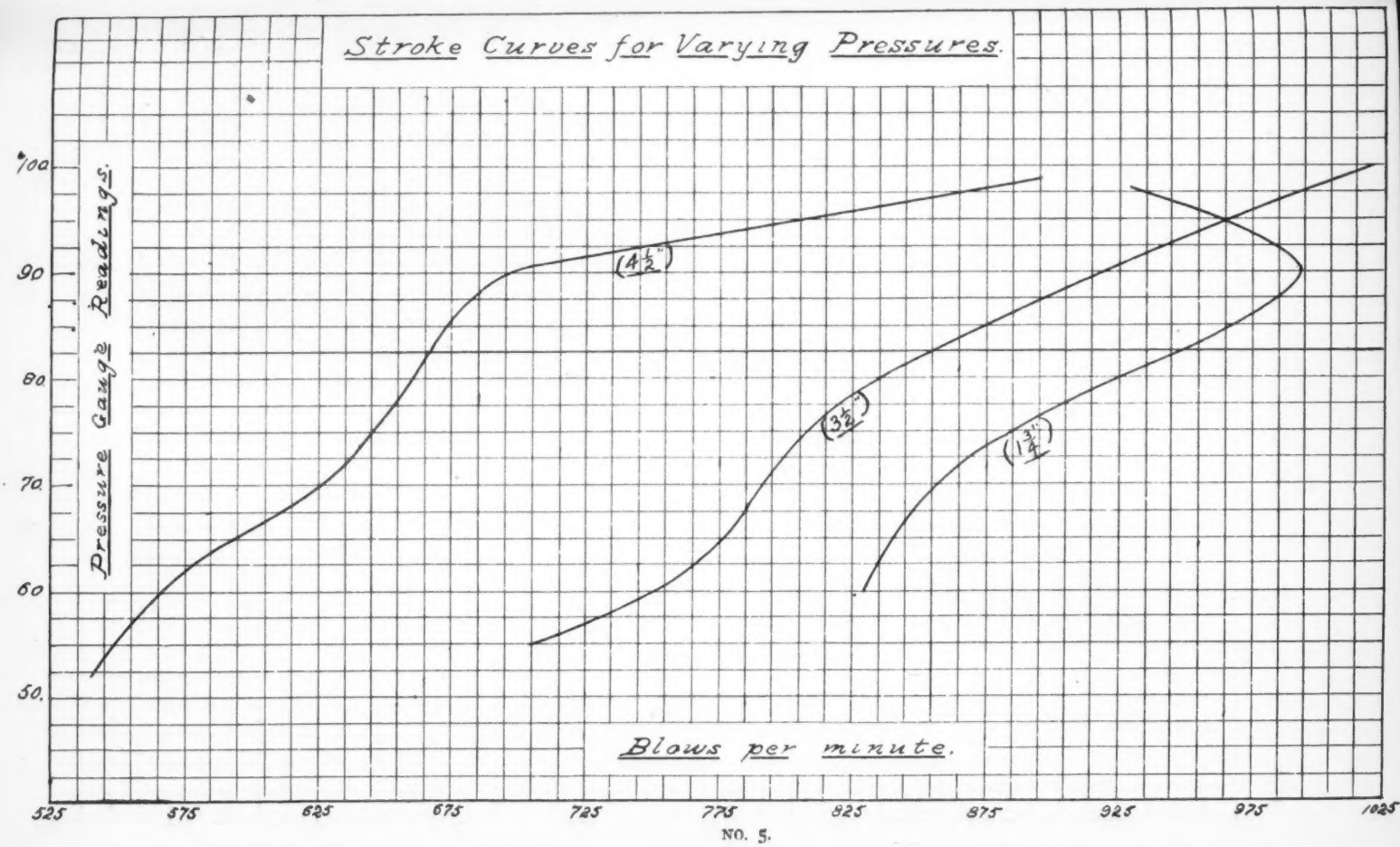
The problem was solved by mounting a roll of stout manilla paper on a vertical spindle so as to be free to rotate. The paper was pulled rapidly in front of the striking drill so as to be punched by it. In this way a long line of holes was obtained in the paper. In practice the drill was run for fifteen seconds, as determined by the stop watch. The number of the


Stroke Curve for Varying Pressures.
Stroke. 1/2".
Pressure Gauge Readings.
100
90
80
70
60
50
Blows per minute
725
775
825
875
925
975
1025
No. 2.

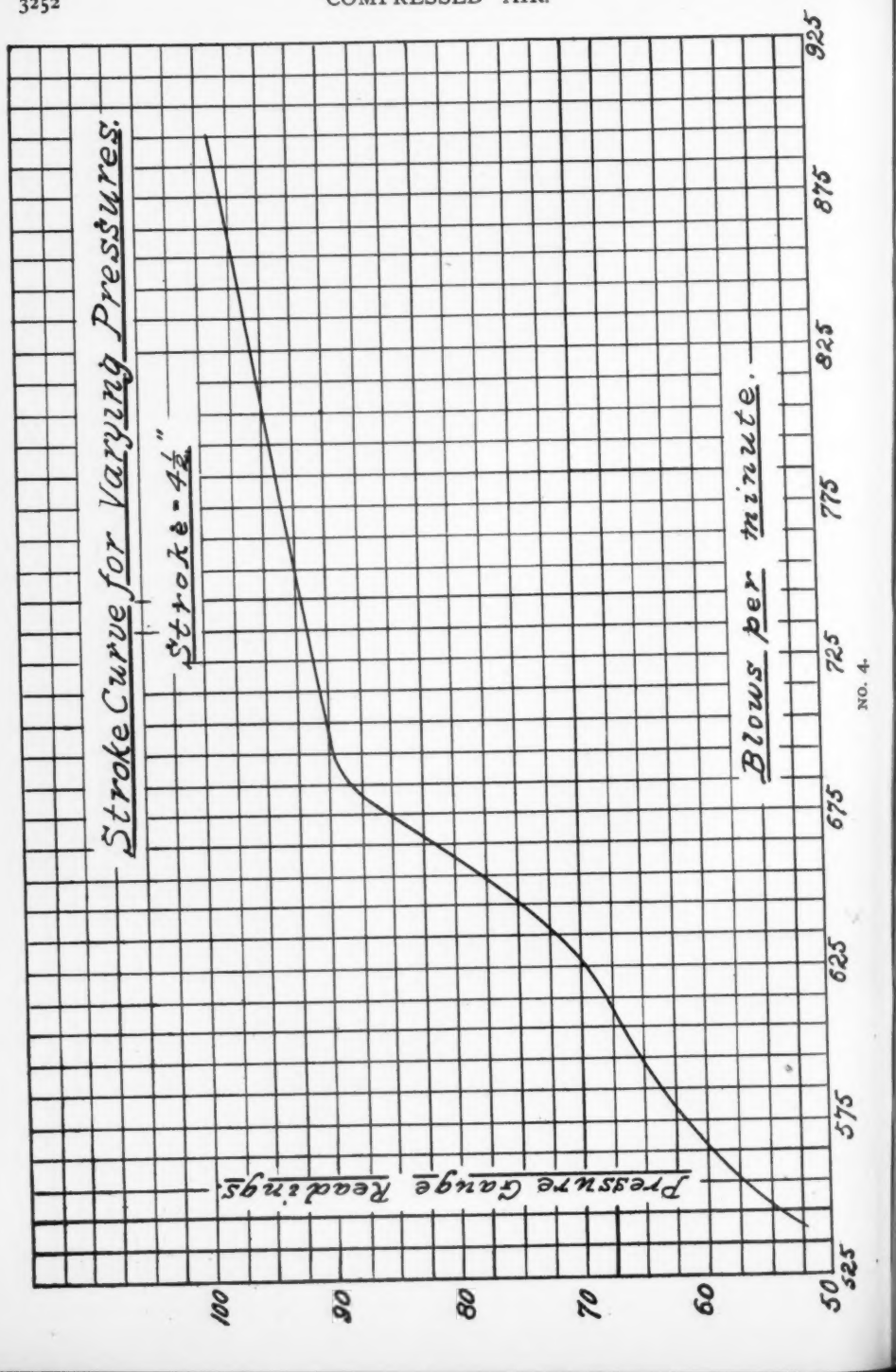

Stroke Curve for Varying Pressures.
Stroke = 3½"
Pressure Gauge Readings.
100
90.
80.
70.
60.
50.
675
725
775
825
875
925
975
1025
Blows per minute.
No. 3.

675 725 775 825 875 925 975

NO. 3.



NO. 5.


Stroke Curve for Varying Pressures.
Stroke - 4½"
Pressure Gauge Readings.
Blows per minute.
100
90
80
70
60
50
525
575
625
675
725
775
825
875
925

NO. 4.

holes made in this time, multiplied by four, gave the number of blows per minute. The time of running had to be short so as to maintain a constant air pressure throughout the test.

Tests were made with the longest, 4½-inch, and shortest, 1¾-inch, practical stroke, and an intermediate stroke of 3½ inches. In each case the air pressure was varied from 50 pounds to 100 pounds. One man held the stop watch and ran the drill, the other pulled out the paper in front of the drill.

TEST FOR NUMBER OF BLOWS PER MINUTE.

Air Pressure.	Stroke of Drill.	Seconds Duration of Test	Number of Impressions During Test.	Blows per Minute.
99	4⅛	15	224	896
87½	4⅛	15	165	664
90	4⅛	15	174	696
80	4⅛	15	166	664
80	4⅛	15	164	656
75	4⅛	15	161	644
75	4⅛	15	162	648
70	4⅛	15	157	628
70	4⅛	15	156	624
60	4⅛	15	142	568
60	4⅛	15	141	564
52	4⅛	15	135	540
52	4⅛	15	135	540
55	3½	15	171	684
55	3½	15	181	724
65	3½	15	194	776
65	3½	15	194	776
75	3½	14¼	191	807
85	3½	15⅛	224	872½
85	3½	14¼	219	875½
95	3½	15⅛	249	962
95	3½	14¼	230	972
100	3½	12½	210	1000
100	3½	15	260	1040

The appended results on the number of blows per minute were obtained in a similar manner to the foregoing. We endeavored to obtain the shortest possible stroke that the drill could hit. It was found that the drill could be started with a 2-inch stroke and after being started the stroke could be reduced to 1¾ inches. Naturally one would expect an increase in the number of blows with a decrease in the length of the stroke, for in a given interval of time the drill has to travel farther in the longer stroke. This result is shown in comparing the 3½-inch and 4½-inch strokes. Up to 90 pounds pressure this result was the same, but at 98 pounds a sudden drop in the number of blows shows that some additional influence to be at work.

TEST FOR NUMBER OF BLOWS PER MINUTE.

Air Pressure.	Stroke of Drill.	Seconds Duration of Test.	Number of Impressions During Test.	Blows per Minute.
69	2¾	15½	210	829
73	2¾	14⅞	215	871.5
82	2¾	15	236	944
90	2¾	14¾	245	993
98	2¾	11	170	927
98	2¾	15	233	932

2. Determination of the air consumption.

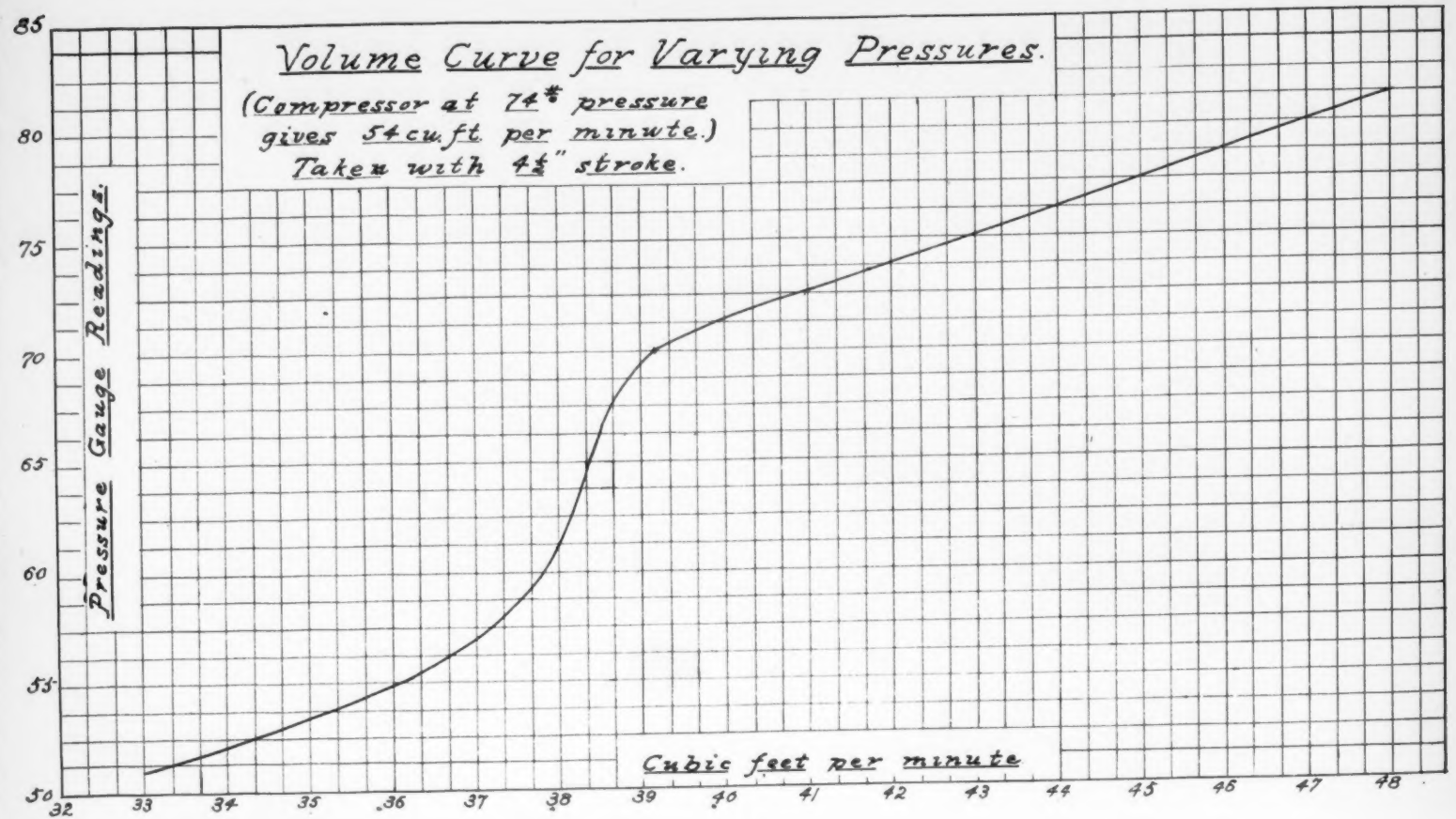
The amount of air consumed by the drill in a given time was determined experimentally and the results afterward checked by calculation. In the experimental determination the problem was to convey the air from the exhaust ports of the drill to a suitable measuring device without any loss. The apparatus finally used was the result of many discouraging failures. The vibrations of the drill were so rapid and strong that any connections fastened to it were speedily shaken to pieces.

Finally a galvanized iron cover or cap was bolted over the two exhaust ports and connected to a 100-gallon boiler acting as a receiver, by means of a canvas hose saturated with shellac, so as to be air tight. The cover over the exhaust ports had first been made of tin, but this was soon shaken to pieces. A rubber hose connecting to the receiver proved to be too rigid, transmitting the vibrations to the rest of the apparatus, and consequently the rubber hose was provided to take its place. The receiver was used to deaden the air pulsations before transmitting to the meters and to allow the air to assume its normal volume. A pipe and T-joint carried the air to two meters of the water type described below.

The results obtained are plotted and tabulated on the accompanying sheets, Nos. 2, 3, 4 and 5. Their interpretation is left till the end of this section.

MEASUREMENT OF THE FLOW OF GAS.

In the measurement of the flow of gas the product of the absolute pressure p by volume v, divided by the absolute temperature t, is a constant quantity, pv equals *const.* If p and T be kept constant the


Volume Curve for Varying Pressures.
(Compressor at 74# pressure gives 54 cu. ft. per minute.)
Taken with 4½" stroke.
Pressure Gauge Readings.
85
80
75
70
65
60
55
50
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
Cubic feet per minute

NO. 5.

quantity discharged will vary as the volume. If p and T are known the quantity can be computed.

Wet Meter Used in Testing.

The San Francisco Gas and Electric Co. kindly loaned two three-hundred-light wet meters for this test. The wet meter is arranged with a series of chambers which are alternately filled and emptied with gas. These chambers are usually arranged like an Archimedian screw. Gas is admitted just above the surface of the water and raises the partition of the chamber, bringing it above the water and filling it. The outlet pipe is submerged until the chamber is filled. The gas is completely expelled as the cylinder revolves.

Provided the water level be maintained at a constant standard height, the water meter is a very accurate record of the quantity of the gas passing. Any change in water level changes the size of the chamber accordingly. The motion of the cylinder actuates the recording mechanism.

Volume Tests.

Pressure.	Reading Meter No. 1, Cub. Ft.	Reading Meter No. 2, Cub. Ft.	Duration of Test.	Total Cub. Ft. per Minute.
70	36	42	..	..
70	42	76	1	40
70	45	110	1	37
70	50	145	1	40
70	55	180	1	40
70	58	216	1	39
70	61	252	1	39
81	76	71	..	..
81	116	79	1	48
80	156	86	1	47
78	194	98	1	45
77	232	100	1	45
75	270	105	1	43
61	16	78	..	..
61	18	114	1	38
61	22	148	1	38
50	30	28	1	..
51	32	59	1	33
51	34	92	1	33
51	36	122	1	33

In order to check the results of the volume measurements the theoretical amount consumed in a number of cases was calculated. This also acts as a check on the number of blows per minute, as this quantity is an essential factor in the calculations.

We first carefully measured the valve chest of the drill and found that the drill takes air for 27-16 inches on the back stroke and 3 13-16 inches on the front stroke.

Area of 2¼ inches piston equal 3.98 square inches.

Area of 1¼ inches piston rod equal 1.23 square inches.

Net area equal 2.75 square inches.

Front volume equal 2.4375 x 2.75 equal 6.70 cubic inches.

Similarly the back volume is 3.98 x 3.81 equal 15.174 cubic inches.

Incidentally this shows the ratio of non-useful air to useful air to be as 6.7 is to 15.17, or 44.2 per cent. With any drills there is practically the same amount of air on the back and forward stroke, but with the Torpedo this valve motion refinement gives a saving of air on the non-useful or back stroke.

The total amount of air consumed at each stroke is 15.173 plus 6.703, or 21.876 cubic inches. If this be multiplied by the number of strokes per minute and the corresponding pressure be reduced so as to be expressed in atmospheres the volume of air consumed will be known.

Assuming 77 pounds pressure, it will be found that there are 655 blows per minute with 4½-inch strokes; 77 pounds is 6.4 atmospheres; 655 x 21.876 divided by 1728 x 6.4 equals 53.12 cubic feet.

For 77 pounds the meter reading was 45 cubic feet of cold air (air was perfectly cooled in passing through the water). Using a standard thermometer, the temperature of the air in the valve chest was found to be 136 degrees Fahr., or 596 degrees absolute, as compared to 520 degrees absolute for normal air.

Consequently 45 x 596 equals 51.6 cubic feet of cold air (good check). Table No. 5 shows the volume curve.

3. Determination of the absolute force of the blow.

This was done in order that the foot pounds of work done at various strokes could be ascertained, and a comparison made of the effects with different lengths of stroke. This problem was finally solved by producing indentations in a lead bar moved rapidly in front of the striking drill and comparing them with a series of similar indentations in a lead bar subjected to a blow of known force. Copper was first tried, but did not prove as satisfactory as soft bar lead, which is more uniform and softer.

By means of a wooden frame, arranged to slide freely on two vertical guide wires and carrying the piston rod and blunt nosed drill (the same moving parts as in the case of the striking drill), the drill was allowed to indent a lead bar placed on an anvil. The piston and drill (weighing 21 pounds) was allowed to fall on the lead through distance varying from 2 feet to 3 feet 6 inches, and from the indentation produced in each case a curve of compression for the lead bar was constructed, as per Curve No. 7. The indentation was measured with a Vernier micrometer.

Thickness of bar equal .2485 inches.

Length of Drop	Original Thickness of Lead Bar	Final Thickness of Lead Bar	Amount of Compression
2' 0".....	.2485	.1976	.0509
2' 2".... ...	.2485	.1898	.0587
2' 4".....	.2485	.1845	.0640
2' 6".....	.2485	.1808	.0677
2' 8".....	.2485	.1785	.0696
2' 10".....	.2485	.1730	.0755
3' 6".... ..	.2485	.1606	.0880

The indentation produced in the bar for 4½-inch, 3½-inch, 2-inch and 1¾-inch stroke was measured in a like manner and by interpolation in the curve of compression for the lead bar the distance was found. From this the velocity v was found; v equals $2gh$: the foot pounds per minute, 21 pounds x H x number of blows per minute: and foot pounds per blow. These results are shown on the accompanying:

TABLE SHOWING ABSOLUTE FORCE OF BLOW AT 98 LBS. AIR PRESSURE.

Stroke of Drill	Indentation of Lead Bar	Drop in Inches	Drop in Feet	Velocity of Drop per Second	Blows per Minute	Foot Pounds Per Minute	Vis Viva of a Single Blow Foot Lbs.
1¾"	.598	26.4	2.2	11.90	975	45044.	462
3½"	.0598	24.4	2.03	11.45	910	38808.	42.73
3½"	.0537	24.8	2.06	11.51	910	39385.	43.2
4½"	.0683	30.4	2.53	12 77	680	36171.	53.19

DEDUCTION AND CONCLUSIONS.

It will be observed that the height of fall for the 3½-inch stroke is less than for any of the other strokes, showing that the 3½-inch stroke does not give the hardest blow and is not the most desirable stroke for this machine; also that the 1¾-inch stroke shows a higher velocity than either the 2-inch or the 3½-inch stroke, but somewhat less than the 4½-inch.

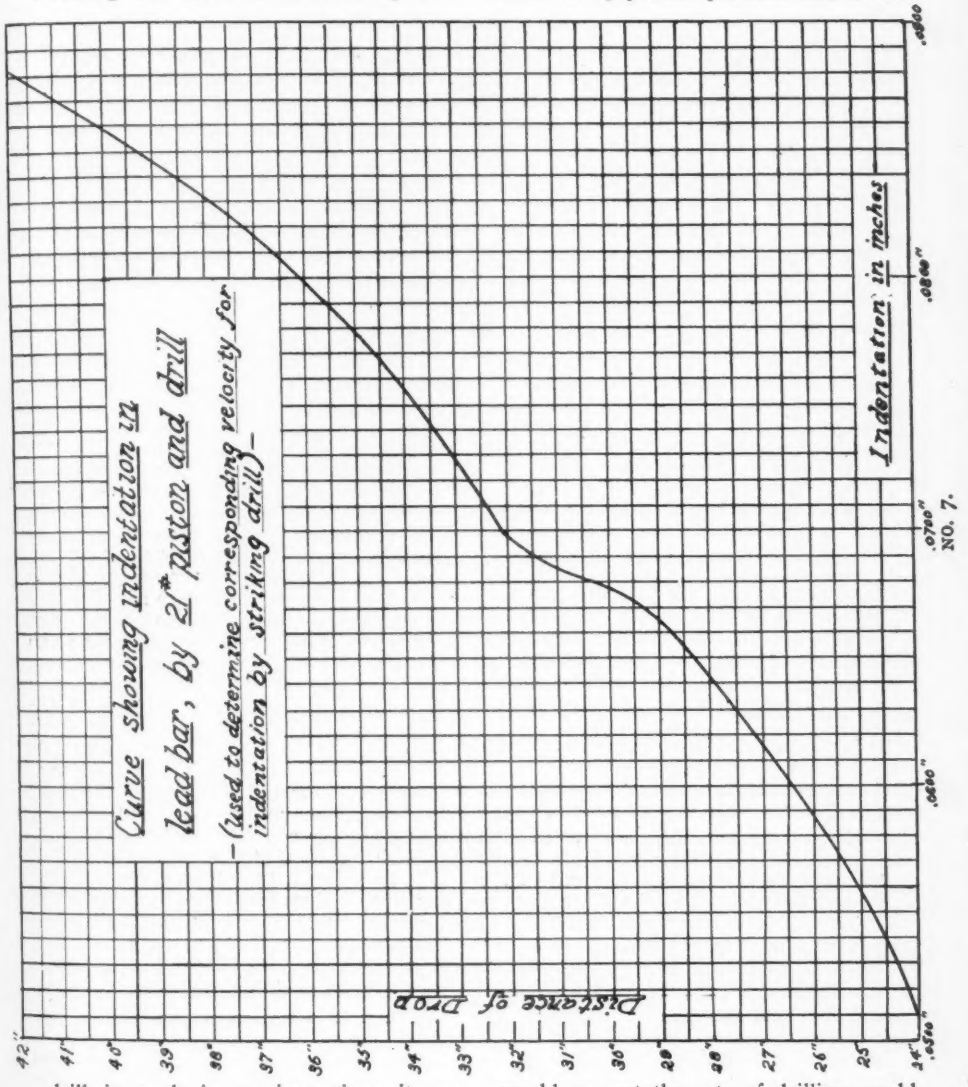
These apparent discrepancies are accounted for by the fact that with the 1¾-inch stroke there is no counteracting influence of cushioning the blow, giving a dead blow and leaving the piston free to move as fast as the valves will work. With the 2-inch stroke there is a slight cushioning effect, and with the 3½-inch stroke the opposing force reaches a maximum. Consequently, when the 4½-inch stroke is reached, although it has the same opposing cushion as the 3½-inch, yet the kinetic energy of the piston in traveling a longer distance is sufficient to overcome more of the counteracting force than is the energy of the 3½-inch stroke.

For the longer stroke it is seen that this drill gives a cushioned blow; that is to say, the valves are so arranged that the air is introduced in the forward chest just before the drill strikes. This is done for two reasons. In the first place, if the air were not introduced until after the blow was struck and the drill had come to a full stop, while the force of the individual blow would be greater, yet the number of blows would be less. It has been found that a greater number of less powerful blows does more work than a smaller number of greater blows. In the second place, if the drill strikes a fissure or other obstruction it will become stuck and cannot be removed if the drill comes to a dead stop, but if the valve be open for the return strike it will be much easier to withdraw the drill.

In studying the force table it will be noticed that the number of foot pounds per blow for the shorter strokes is less than for the longer strokes, but owing to the increased number of strokes the total work done is more with the shorter stroke. This has been found true in actual practice, and were it not for the fact that the short stroke will not clear mud from a hole more than 18 inches deep, the rock drill could employ the short stroke with advantage. As it is, the short stroke is limited to short holes for starting.

It is interesting to note here an unsuccessful attempt that was made to find the force of the blow on rock, instead of on lead. It is easily calculated that 9.000 pounds moving .0683 of an inch in lead

has the same vis viva as 53.2 pounds dropping 1 foot (the foot pounds per blow of 4½-inch stroke at 89 pounds pressure). In an analogous manner, knowing the distance traveled by the drill in rock in a given time, it was hoped to calculate the force of the drill on rock. But this was found to be practically impossible, because the hole would have to be kept absolutely clear, and the drill as sharp at the finish as at the start, so as to have homogeneous progress. While this drill will drill 4 inches in a minute at 85 pounds pressure and about 700 blows, yet the rate of drilling would be constantly decreasing as the hole became chocked and the drill duller.



NO. 7.

After the completion of our work on

this determination, considerable interest was aroused by the appearance of the following communication in the *Mining and Scientific Press:*

"The force of a blow may be defined as the average pressure which would accomplish the same result as the blow. In general, a blow is the result of a small weight moving at a high velocity.

"The high pressure developed by the blow is the result of the sudden stoppage of the rapidly moving weight. To calculate this pressure it is necessary to find the amount of energy in foot pounds stored in the moving weight, and the energy can be found if we can measure the velocity of the weight the instant it strikes.

"To measure the velocity of the drill is by no means a simple matter, especially in the case of a power drill.

"On the other hand, if we did know the foot pounds of energy in the moving weight, we cannot obtain the average pressure on the drill without knowing the time during which the steel is moving forward into the rock under the impelling force of the blow. This space of time is so short as to be imperceptible and cannot be measured except by very elaborate and expensive apparatus.

"Therefore the measurement of the force of the blow in a power drill is not likely to be accomplished outside of a very richly endowed laboratory."

The writer of the above, Mr. Lewis Searing, of the Denver Engineering Works, then makes an assumption that one-half of the energy delivered to the Box Electric Drill is actually active at the cutting end of the drill. Knowing the distance through which the drill travels in a minute, he calculates the average pressure throughout that distance as 50 tons.

While not questioning the value of such a method of calculating the force of the blow, yet the assumption that half of the power delivered to the drill is used by the cutting end of the drill does not seem to be justified by experiments.

The method employed in our experiments gives the force of the blow struck on lead. This force will be different for different substances having a different resistance to indentation. Consequently the force of the blow on rock will be different from that on lead. But the method is applicable and valuable for determining the "absolute comparative" force of blow struck by different machines. In this way an accurate record can be obtained as to which machine strikes the harder blow. One advantage of this method in measuring the force of the blow lies in the fact that it compares indentations both produced by impact. It is assumed that the blow produced by impact is somewhat different from that produced by the same number of foot pounds applied as a pressure.

Conclusions From Form of Curves.

Upon comparing the volume curve with the number of strokes curve, similar pressures being plotted on both, one is struck with the general similarity in form. This carries out the theoretical law that the air consumption must vary as the number of strokes.

Carrying on the study of the curve showing the number of blows per minute, it can be determined as to what is the best pressure to run the drill. It must be assumed that the amount of progress in the drill hole must be proportional to the number of blows struck. This being the case, it will be noted with the 4½-inch stroke, with from 80 to 90 pounds pressure, there is an increase of only 40 blows per minute, while in the corresponding increase of pressure from 85 to 95 pounds there is a difference of 125 blows. From here the curve runs off very rapidly until at 100 pounds there are 900 blows. The difference in power to compress air at 90 and 100 pounds is only about 6 per cent., while the gain in blows from 700 to 900 is about 30 per cent. This shows that the same machine will do much more work proportionately at higher pressures. It will, however, require an increased consumption of air, but inasmuch as the plant is installed to drill holes and not to economize air, the result is worth the cost.

With the short stroke curve, 1¾-inch, it will be noticed that at high pressure the number of blows is reduced as the pressure increases and the curve turns back. The exact reason for this is not known, but it is supposed that the drill misses an occasional stroke with high pressure and short stroke.

By comparing the three curves of number of blows per minute it will be noticed that the 3½-inch curve is the most rational and approaches more nearly the form of a straight line. It has been suggested that the data from about a 3¾-inch stroke would give a straight line shows

a steadily increasing number of strokes for a steadily increasing pressure.

The study of these curves suggests the value of a careful investigation of the character of every rock drill and the condition under which it will do the best work. For instance: the assumption that an increased pressure means increased work is not always true. From the results of this thesis it has been suggested that the following method of handling this drill in a contest would probably give the best results: Supply air from the compressor at 100 pounds. In starting the hole, for the first foot or 18 inches run with short stroke and partly closed cock to reduce pressure. When the drill can no longer clear the hole, run at full stroke and full pressure until the hole is drilled.

Recognition and acknowledgment is due for the many courtesies extended to us by Mr. E. A. Rix. He placed at our disposal the Torpedo Drill, the air compressor and electric motor for running it, and gave us perfect freedom to construct any required apparatus in the shop where the drills are made. He also obtained the necessary measuring instruments and apparatus. Much of our success is due to his counsel and suggestions. Much of our work was done on Sundays, holidays and at other times when the men were away, so that our work would not interfere with the regular work of the shop and office, and their work would not interfere with ours.

Coal Cutters in England.

In a recent issue of the *Colliery Guardian* some interesting statistics regarding the use of coal-cutting machines in the United Kingdom are given. These are taken from the general report relating to mines and quarries for 1903. The *Colliery Guardian* says:

"Exact statistics have again been obtained with reference to the use of coal-cutting machines in the United Kingdom. From the following table it appears that in 1903 there were 225 collieries where coal-cutting machines were at work. The total number of machines employed was 643, of which 231 were worked by electricity and 412 by compressed air; the total quantity of coal obtained in 1903 by the aid of these machines was 5,245,578 tons—this is an increase of 1,084,376 tons compared with 1902 and 2,201,257 tons compared with 1901.

"NUMBER OF MACHINES AND OF COLLIERIES WHERE USED, MOTIVE POWER EMPLOYED AND QUANTITY OF COAL OBTAINED BY THEIR USE IN THE VARIOUS INSPECTION DISTRICTS DURING THE YEAR 1903.

DISTRICT.	No. of Collieries where Machines are at Work.	Number of Machines.	Worked by		Coal Obtained.
			Electricity.	Compressed Air.	Tons.
East Scotland	25	56	21	35	497,892
West Scotland.....	26	73	14	59	650,132
Newcastle	14	43	13	30	348,025
Durham.....	21	61	40	21	343,412
York and Lincoln....	41	158	60	98	1,578,383
Manchester and Ireland	18	35	8	27	151,762
Liverpool and North Wales	19	77	8	69	520,673
Midland	45	108	53	55	888,578
Stafford.....	10	24	14	10	244,971
Cardiff.....	2	2	—	2	8,322
Swansea.....	2	3	—	3	9,415
Southern.....	2	3	—	3	4,013
Total in 1903.....	225	643	231	412	5,215,578
Total in 1902.....	166	483	149	334	4,161,202

"The table shows that there has been a considerable advance both in the number of machines used and in the output of mineral. The increase in the number of machines has the greatest significance, for in many mines they were introduced late in the year, and a greater increase in the output may be expected in 1904. There is now ample evidence that British mining engineers are alive to the economical importance of coal-cutting machinery. Trials are being made at many collieries with different types of machines, the object being to decide which type is best adapted for the particular work, and it is safe to predict that a large percentage of the output of the United Kingdom will be obtained by coal-cutters in the near future.

"Coal-cutting machines could probably be used with advantage in getting fire-clay."

A New Sand-Blast Apparatus.*

Air, water and steam are the mediums at our disposal for the working of the sand-blast machine, each of which gives

*By Francis Sticker in the *American Machinist*.

the sand special, singular properties which must be considered in the construction as well as in the use of the machine. Sand-blast machines use compressed air to give the sand certain desired qualities. It is a well-known fact that all compressed gases develop a very high velocity while escaping from a closed vessel. In previous machines the velocity of this escaping gas, as air, for instance, has been utilized to give a mixture of sand and air the highest possible velocity to perform certain work, as cutting, cleaning, etc. Undoubtedly, the velocity of a given mass is able to remove resistances, such as scale or rust on iron, dirt on stone buildings or paint on iron fences; but proper mixing of the sand and air is the most important consideration, and not the velocity of the air.

The theory and practice of jet apparatus in general, and the steam injector in particular, clearly outline the way to build a perfect jet apparatus for air and sand, or for any other mixture where thorough mingling and velocity are to be created. In steam injectors, the steam is utilized only to create a suction to elevate the water; but after this has been accomplished every conceivable means are adopted to harness this velocity and transform it to more useful purposes; that is, power, first, to give the water and steam time for mixing, then to allow this mixture to attain the necessary power to overcome any friction in pipes or valves and the overpressure of the boiler. For example, steam entering an injector with a velocity of 1,900 feet per second, at a pressure of 120 pounds, leaves it with only a fraction of its original velocity after being properly mixed with water; and even after imparting the necessary motion to the inert water it attains an end pressure far exceeding its initial one, so that actually a boiler having only 100 pounds pressure, in connection with an injector, can easily feed another boiler carrying 130 pounds or more pressure.

The foregoing clearly outlines the manner of construction of any jet apparatus, especially a sand blast, and therefore the apparatus to be described will be readily understood.

The design shows a tank or casing supported by several legs; but it can be suspended just as well. The tank is made with a small hand-hole for the examination of the inside or to make any repairs necessary. On top of the tank is an opening for filling it with sand, which opening is closed by a screw plug after the tank has been filled. In the centre of the top of the tank is a small casing forming a chamber. A pipe closed at the upper end is threaded in the top of this casing, and carries a handle on its outer free end. The pipe can be moved up or down by turning the handle to the right or left, and extends to the bottom of the tank. Near its upper end at a point within the chamber the pipe is provided with one or more small apertures which allow communication between the inside of the pipe and the chamber. At a point within the tank additional apertures afford communication between the pipe and tank. On the lower end of the pipe is screwed a cup-shaped valve which fits into an opening in the bottom of the tank, and by raising or lowering the pipe by means of the handle the valve opens or closes the sand reservoir and regulates the outlet for the sand. At the bottom of this valve is a jet-formed nozzle which affords communication between the pipe, the valve and the outside of the tank. As will be seen later, this mechanism admits air into the upper portion of the tank and through the pipe to the lower outlet of the tank, and at the same time regulates the outlet of sand.

A knee-shaped casting called the mixing chamber, and entirely new in sand-blast machines, extends downward from the lower part of the tank. The nozzle of the sand regulating valve extends vertically into this mixing chamber, and controls communication between the tank or sand reservoir and the mixing chamber. Further pipe connections on the outside of the mixing chamber indicate two other inlets, one on the bend of the knee extending vertically; another below extending horizontally in line with the outlet to a flexible rubber hose attached to the mixing chamber. Their use and purpose will be shown later on. The end of the hose is supplied with a nozzle to direct the mixture of sand and air wherever desired.

Below and to the left of the tank or casing is shown, in Figure 1, a cock controlling communication between all the outside pipe connections and the tank

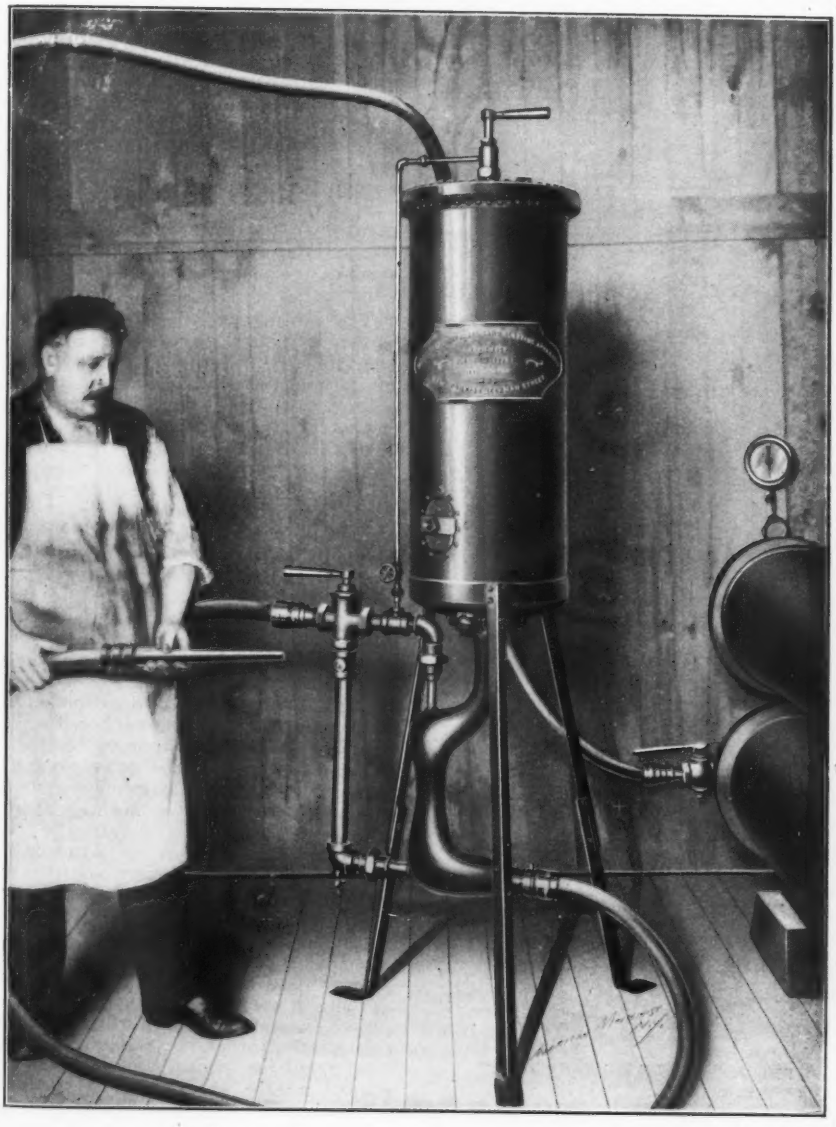


FIG. I. THE STICKER SAND BLAST.

and mixing chamber. This cock admits and regulates the air supply. The construction of the cock is such that by its movement the operator can either admit air consecutively to the sand reservoir,

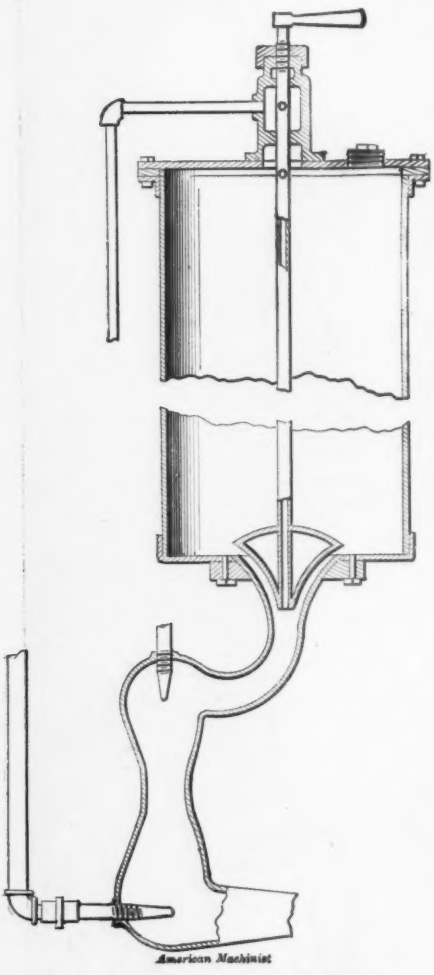


FIG. 2. SECTION OF SAND BLAST.

the pipe, the different nozzle connections on the mixing chamber, or simultaneously to all of them. The cock is connected to a reservoir which furnishes the motive power.

Compressed air is admitted to the air admission cock or valve by means of a rubber hose, or by any other means of communication, especially if the plant is stationary. As described previously, three different and distinct pipe connections lead from this air admission cock. One small pipe extends to the top of the tank or sand reservoir into the chamber thereon which it communicates with the interior pipe. Another pipe affords communication with the upper vertical part of the mixing chamber, and the third with the lower horizontal part of the mixing chamber. The sectional view of the air admission cock shows its construction.

The tank having been filled with the quality of sand decided upon for the special work in hand, and closed tightly by means of the filling plug, the operator admits compressed air to the machine by means of the air admission valve. The first slight turning of the cock admits air to the sand reservoir, the sand regulating valve being closed. The air will enter through the upper apertures in the pipe and partly escape through those slightly above the normal level of the sand, and exert a slight pressure on the sand itself, on account of the holes being very small and the air flow not being confined to the inner part of the sand reservoir, as the escaping air finds another outlet down through the sand regulating nozzle into the mixing chamber, and from there through the rubber hose and nozzle into the atmosphere. A further slight movement of the sand regulating valve opens communication between the sand reservoir and the mixing chamber. The cup-shaped valve, giving a wide area for the outlet of the sand, distributes it over a wide surface and makes it run more easily than when forced through a small opening where there might be danger of clogging, as sand when wet has a tendency to do. The gravity of the sand, in connection with the slight pressure on top of the same, and the suction created through the bottom nozzle, forces the sand through the sand regulating valve, and into the cup-shaped nozzle, spreading the sand into a fan-shaped cloud and bringing it into contact with the air escaping through the valve. The cup-shaped valve tapers down as it extends into the mixing chamber to a gradually contracting area

or neck, so that the sand coming out in the form of a cloud is again gradually contracted and brought into close contact with the issuing air. The sand and air mixture again has a chance to escape and form a cloud, and by this time the operator having opened the air cock further, air enters the upper vertical por-

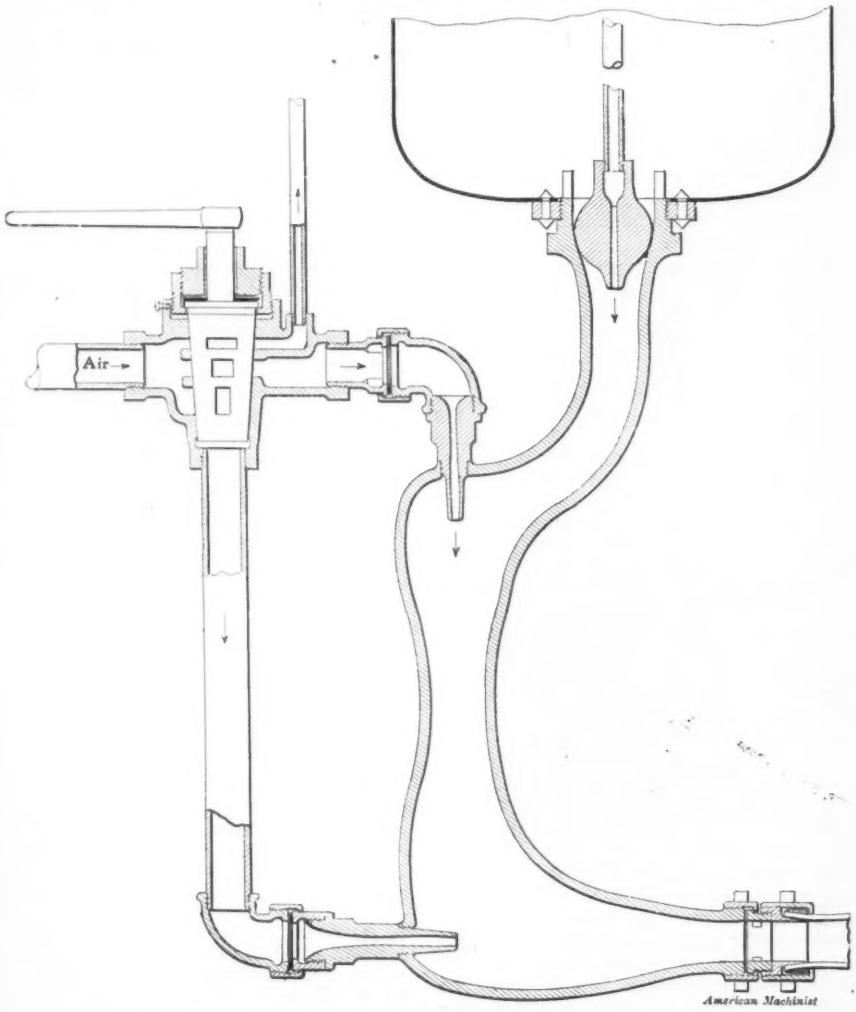


FIG. 3. SECTION OF MIXING CHAMBER NOZZLES, HOSE COUPLING AND REGULATING COCK.

being mixed together by this process then pass through the narrow neck into a gradually widening opening, where the tion of the mixing chamber, meets the cloud mixture and carries the same down to a slowly narrowing passage again,

where there is a slight compression, and consequently a further mixing of the air and sand takes place besides bringing the mixture directly into the line of air discharged into the vertical part of the mixing chamber. Passing out of the narrow passage, the mixture is driven into the lower bell-shaped portion of the mixing chamber, and the air cock having been now fully opened, admits the compressed air to the lower horizontal portion of the mixing chamber, where the air meets the mixture and forces it out of the tapered end of the mixing chamber into the rubber hose and through the nozzle fastened thereon, into the atmosphere.

It will readily be seen that the repeated expansion and contraction of the sand and air by means of the peculiar construction of the mixing chamber has a tendency to retard the flow of the air and reduce its velocity, which gives it sufficient time to mix with the sand, so that when finally air and sand leave the end nozzle, we have a thoroughly mixed sand blast whose force lies not in the velocity of the air, but in the absolute density of the volume of air and sand, and the result is a highly efficient and economical sand blast. Not a particle of air or a grain of sand is wasted in the use of the apparatus. This construction not only improves the working of the machine, but it requires the minimum amount of repairs. In the Sticker apparatus the couplings, bore and nozzles last almost indefinitely, for the reason that the diminished velocity reduces the wear and tear to a minimum.

The construction, as well as the dimensions of the nozzle are of course of the highest importance. The construction must follow the laws of the flow of air under different pressures, and the sizes must gradually increase from the upper or first nozzle down to the last one. An increasing impetus must be given the jet to make it efficient, as well as to avoid any forcing back into the sand reservoir itself; for it must be understood that the outlet nozzle on the end of the rubber hose is considerably smaller than the combined areas of the other nozzles used in the machine. It has been found by actual practice that the amount of air requisite to make the blast powerful is very small when adopting this principle, and that the air compressor may be correspondingly small.

The nozzles, especially the one at the end of the rubber hose, are all made of the best tool steel, reamed and finished to the proper size and shape, and not from gas pipe, which wears out in a very short time. A properly formed nozzle lasts almost indefinitely under the conditions mentioned.

Among the details of this machine, the hose coupling shown in Figure 3, specially designed for it, deserves attention. It is of the highest importance to give the jet a regular, even flow, avoiding all sharp corners or edges, and this is accomplished in this hose coupling. As the illustration shows, the hose is slipped over a tapered portion of the main part of the coupling, a tapered ring is put around this, and a nut is screwed on which brings the ring forward and presses it together around the rubber hose without injury to it, and at the same time making a reliable and tight joint able to withstand any pressure. There are no sharp edges, and the flow of sand and air is absolutely unhindered, while the area of the hose, as well as the nozzle next to it, is identically the same.

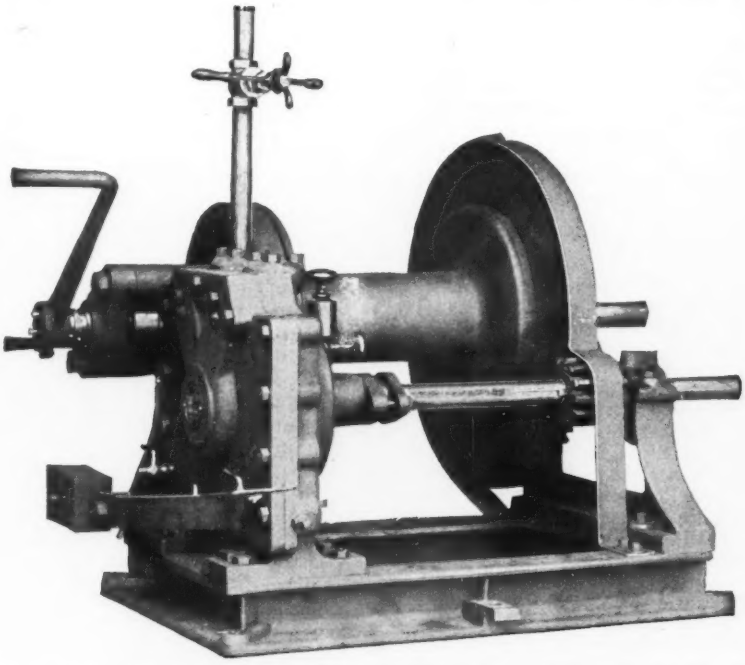
The air admission cock, also shown in Figure 3, contains a new feature. It is well known by users of steam, air or water cocks that they have a tendency to stick. It will be seen that in this cock the upper portion of the plug is provided with a shoulder, and that by means of the stuffing-box construction it is possible to slightly loosen the cock should occasion demand it.

The air pressure required depends entirely upon the class of work to be sand-blasted. Glass and soft material need very little pressure, and the same is true for cleaning castings and the fronts of stone houses, while steel plates, pipes, granite, etc., require greater pressure. But in most cases it will be found that it is more the selection of the proper kind of sand than great pressure which makes the machine efficient. Sand can be obtained in many varieties, natural and artificial; but care must be taken to have it uniform. The sand should have sharp cutting edges, and this is seldom found in beach sand, where the continual rolling rounds off the corners.

A great advantage of this machine is the fact that the sand, if a little moist,

will not clog, the construction in itself keeping the sand and air in constant motion, primarily because of the suction created at the bottom of the tank, since, if the only pressure were that upon the top of the sand the strongest air blast would not force sand from the tank.

Different nozzles are used for different classes of work. While in one instance it might be advantageous to have a small, powerful jet, in another it might be better to have a large spray to cover more space in a shorter time.



A DAKE SQUARE PISTON ENGINE DIRECT CONNECTED TO A FRICTION DRUM HOIST.

The Dake Motor for Foundry Service.

The Dake square piston engine, built by the Holland Company, of Chicago, Ill., is a compact motor, which may be operated by compressed air or steam. It is built in sizes of from 1 to 20 horse-power, in a form that is peculiarly adapted to the direct driving of blowers, pumps, hoists and machinery of almost any class, and for this reason is useful for many purposes in foundries. The acompanying illustration shows the motor applied to a drum friction hoist, a shape in which it may be used for raising a large weight for casting smashing and for raising charging lifts or other hoisting machinery. It runs equally well upside down or in a vertical position. Other special services to which the motor may be put in the foundry are the operation of jib or traveling cranes for the handling of flasks and castings, or the raising, lowering and pouring of ladles. It is easily capable of running a crane that requires several men to operate it by hand power, and will raise the load in about one-fifth of the time. One of these motors may be applied to any ordinary hand crane simply by removing the cranks and without changing the gearing in any way. Being completely inclosed in an air tight case, it is well protected from the fine dust and dirt that invariably prevails in foundries. In the outfit illustrated a friction lever and

foot brake are provided. The lever is shown in the position for lowering the load. In the opposite position 45 degrees over, it starts the drum for hoisting and in the central, or neutral, position the drum is fixed and the load held stationary. A similar equipment is made with a tight drum instead of a friction drum, and a reversible engine is used, so that power is used for both hoisting and lowering.—*The Iron Age.*

Competitive Drilling Tests.

From time to time the mining journals and technical society publications print the results of competitive tests of various makes of machine drills. These so-called tests are usually made under uniform conditions at some place on the surface, but these artificial arrangements do not approximate the conditions found under ground in the mine. The artificial surface conditions prepared for the trial of durability, speed of cutting, facility of setting up and taking down the machine, cost of operating, and repairs, air consumption, and all other data which should be included in a bona fide test, and which would be of real value in determining the respective merit of the various machines on trial, usually consists of a large block of granite, rarely if ever over 30 inches thick, set horizontally. The drills are clamped to a horizontal bar; all holes are "down holes;" the limit of depth of hole is about 2½ feet; in fact, all of the physical conditions, although eminently fair and alike for each machine, are so totally unlike those found in the mine that a test of this kind has little of value in it. In mine work very few of the holes cut are drilled vertically downward—even in shaft sinking the greater number of holes are drilled at an angle, the end holes being the only ones usually to approximate the vertical. Some drills operate much more satisfactorily on down holes than others, and different sizes of the same make of machine give differing results in drilling down holes.

Another and important feature of test drilling is often noticed in the careful preparation of the machine to be used in the drilling contest. If these alterations, so carefully made at this time, are to the advantage of the drill—and they appear to be—why do not the manufacturers make the machine as perfect as this specially prepared drill? In a drilling contest there are several factors of importance, and upon these should the judgment be based as to their relative efficiency. Each machine should be of the kind sold to mining companies, just as they came from the shops; without extra care being given it in the finishing and polishing of cylinders, etc. The size of piston in each machine subjected to the test should be of the same diameter; the size of drill bit employed should be the same in each drill; the air pressure should be as nearly identical as it can be made; all holes should be drilled in the same direction and to a depth of not less than 4 feet. Short trials are of little value. Where miners have a drilling contest and drill single or double-handed, the quick work done at such times merely illustrates the result of physical training, and is an interesting exhibition of the skill and energy of the men, but in machine drilling such "spurts" are not tests of possibilities or of the enduring qualities of the machine, nor do they furnish any idea of the cost of keeping the drill in repair—an item of no small consequence. As a matter of fact, about the only "test" such trials demonstrate is the amount of free air consumed per minute. The only test which is worthy of consideration is that of continued work under the varied conditions found in the mine, and these extended over a period of at least a month will afford, not only a knowledge of the drilling capacity of each machine, but also the expense of repairs, etc., which are a matter of important consideration. A recently published article in a technical journal gives as a record for a specially prepared machine drill, the cutting of 13,104 feet of holes drilled during a period of fourteen months (about 27 feet per day, which is a very low efficiency unless the rock drilled was extremely hard. A good machine should drill from 40 to 50 feet per shift in hard greenstone.) The cost of repairs, etc., amounted to about $33 per month, exclusive of $45 expended in fitting up the machine for this special trial. These bills of expense are very heavy, and are not complimentary to either the drill nor the runner.—*Mining and Scientific Press.*

The Gasoline Motor Adapted to Rock Drilling.

The adaptation of the gasoline motor for the operation of the percussive rock drill is the basis of an English patent recently granted to T. Warsop, of Coniston, County of Lancashire, England. One or more cylinders are used, the piston or pistons of which are actuated by gasoline or other inflammable substance, vaporized, compressed and fired therein in the usual manner; or vaporized and compressed in another cylinder. This piston has at-

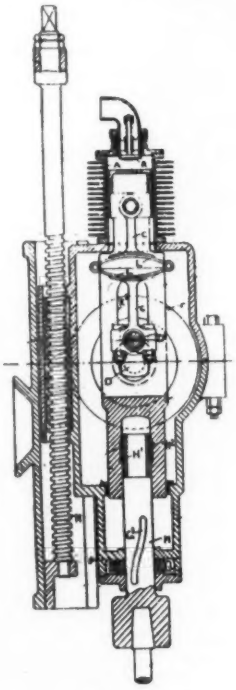


FIG. 1.

tached to it a connecting rod, actuating a crank shaft fitted with one or more flywheels or discs, and the necessary gear wheels or other mechanism for controlling the cylinder exhaust or other valves. The crank shaft revolves in suitable bearings formed in the frame or castings which carries the cylinder at one end, and at the other end carries the rotating gear for turning the spindle or socket in which is fixed the steel drill, jumper or other tool for boring holes in the rock, or for performing other work. The spindle or

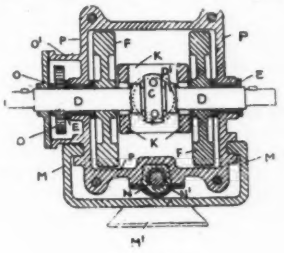


FIG. 2.

socket carrying the jumper or other tool is attached to a motor piston by a suitable casting, so slotted or formed as to re-

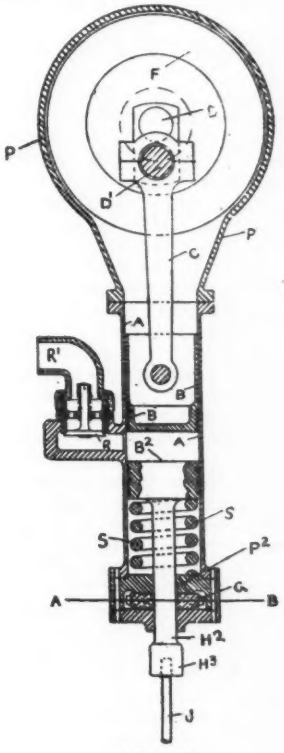


FIG. 3.

ceive the connecting rod and allow the crank to revolve therein; by this means the reciprocating motion of the piston is

conveyed to the drill spindle and to the jumper or other tool carried by it, which latter forms holes in the rock and the like, or performs other work by a percussive and gradually rotating action—when so required—in the usual manner. The whole arrangement described above is covered in or protected where necessary, and is carried by and slides in a cradle or carriage fitted with a feeding screw, handle and the like; all carried by a tripod or stretcher bar, or by other suitable means in the usual manner. Figure 1 is a vertical section of the improved rock drill. Figure 2 is a transverse section in plan of the drill on line 3-4 of Figure 1, and Figure 3 is another form of improved rock drill, having its motor piston unattached to the spindle carrying the jumper or other tool.

Liquid Fuel for Marine Service.*

We have referred already in these columns to the important trials being conducted under the direction of the Bureau of Steam Engineering of the United States Navy upon the practicability of using liquid fuel for naval vessels, and the appearance of the complete report forms a fitting climax to the career of Rear Admiral Melville as Engineer-in-Chief of the navy, and Chief of the Bureau of Steam Engineering. Although the report has appeared since the accession of his successor, it represents work done during the incumbency of Admiral Melville, and the portly volume forms a most valuable contribution to the science of steam engineering. It is to be hoped that the rumors of the abandonment of the policy of publicity in the engineering work of the Bureau hereafter are unfounded, and we trust that Rear Admiral Rae will endeavor to make his Bureau of the same value to the engineering profession as his honored predecessor has done.

The report, which has been made by Commander J. R. Edwards, Lieut.-Com. W. M. Parks, and Lieut.-Com. F. H. Bailey, all of the United States Navy, is most exhaustive in its character, and is published in extensive abstract in the *Journal of the American Society of Naval Engineers,* and we give here some account of the work and the general conclusions which have been drawn.

The report is based upon a number of practical trials, the most complete of these being made by the Board itself upon a water-tube boiler arranged in the Washington navy yard in a manner reproducing as closely as possible the conditions obtaining on shipboard. To these have been added reports of the practical experience upon vessels, notably the voyage of the *Mariposa,* between San Francisco and Tahiti; the *Alameda,* between San Francisco and Honolulu, and the *Nebraskan* and the *Nevadan,* between New York and San Diego, California.

In the report are included detailed accounts of the construction and operation of the various forms of burners used, and a mass of practical experience acquired in the course of the trials.

Within the space here available but an abstract of the conclusions can be given, but the full report should be studied by every one interested in the use of liquid fuel for the generation of steam, whether afloat or ashore.

In the first place, there is no difficulty in burning oil in a uniform manner, and the necessary skill can be readily acquired by the labor available. The spraying of the oil may be very conveniently effected by steam, and for stationary plants this will probably be found the best method. On shipboard, however, the consumption of steam for spraying makes increased demands upon the evaporating plant for the supply of fresh water to the boilers, and hence compressed air is to be preferred. When the combustion is to be forced, as must undoubtedly be required on warships in emergencies, the best spraying medium is highly-heated compressed air.

The presence of water in the oil interferes materially with satisfactory combustion, and special provision should be made for the removal of the gradual accumulation of water in the bottom of the supply tanks. So far as evaporation is concerned, there is practically no difference between crude and refined oil, from 3 to 3½ barrels of oil being equivalent to a long ton of ordinary coal, while 4½ barrels of oil are required to evaporate as much water as a long ton of best Cardiff or Pocahontas coal. In addition to the advantages derived from the heating of the air it is advisable to have the oil heated, this aiding in securing uniformity of flow, while care-

*Tests conducted by the Liquid-Fuel Board under the direction of the Bureau of Steam Engineering of the United States Navy.

ful provision should be made for straining the oil to prevent the choking or clogging of the burners.

While it is doubtless desirable that installations for oil fuel should be designed for use with liquid firing, it is not difficult to apply the system to existing plants. The simplest furnaces show the greatest efficiency, and there is no necessity for filling up the combustion space by the construction of brick arches. In Scotch boilers there should be a simple vertical brick lining of the back combustion-chamber wall, and a lining of the front end of the furnace for about a third of its length.

Experience has shown that when oil is used as fuel in Scotch boilers the introduction of retarders in the tubes will prove beneficial, not only by preventing the products of combustion from passing too freely through the tubes, but also because of the more uniform distribution of the gases through all the tubes. Where oil is properly burned it can be regarded as a fact that the velocity of the flow of the gases is greater than where coal is used, on account of the retarding action of the soot formed in the tubes with coal firing. Retarders should therefore be used in the case of fire-tube boilers, and increased baffling in the case of water-tube boilers.

The efficiency of oil plants will be primarily dependent upon the character of the installation of fittings and auxiliaries. The form of the burner, so long as it is manufactured in accordance with certain well-known principles, and all its parts are accessible for overhauling, will play a very small part in extending the use of crude petroleum. The method and character of the installation is all-important, and therefore the work of designing and constructing such a plant should only be intrusted to those who have given careful study to the matter, and who have had extended practical experience in burning the crude product. Consumers should take especial care that they neither purchase appliances that have been untried, nor permit the installation to be effected by persons who have had but limited experience in such work.

Where crude petroleum has undergone a slight refining or distillation no ill-effects result to modern steel boilers. From the standpoint of endurance of the boiler, however, the advantage, if any, is with oil. Crude oil, however, by reason of its searching and corrosive effects, has a greater tendency than refined oil to attack the seams and tubes of modern boilers. For marine work, therefore, no crude petroleum should be used, and particularly for ships making long voyages the fuel oil should undergo some mild distillation before being placed in the tanks.

The report emphasizes the point that no attempt should be made to use oil as auxiliary or supplementary to coal. Such an installation is certain to prove unsatisfactory, and the solution of the oil-fuel problem for naval purposes is only delayed by any attempt to inject a limited supply of oil fuel over a bed of incandescent coal. The mechanical features of the problem having been satisfactorily met, the good of the service requires that any installation attempted should depend upon oil as fuel alone and not in any combination with coal.

The most important portion of the report, however, after the entire practicability of the mechanical details of burning liquid fuel have been demonstrated, lies in the recommendations with regard to the supply. It is shown that the available supply of the world's supply of crude petroleum would not meet over 3 per cent. of the world's demand for coal and other combustibles, and hence efforts should be made to use oil fuel for special purposes only, and in particular localities.

In view of the fact that 48 per cent. of the world's output of crude petroleum is produced in the United States, and that practically the entire yield is secured from fields which are in pipe-line communication with important and strategic ports the Board considers that a joint commission representing commercial, manufacturing, maritime, and naval interests should be authorized by Congress, whose province it would be to formulate such rules and regulations as would provide for an economical, efficient, enduring, and safe oil-fuel installation. Heretofore the oil-fuel problem has been principally investigated by various individual interests which have sought to secure information along certain lines and as a result there has not been secured that knowledge of the subject which would insure for the country at large such development of the use of crude oil for fuel as would be warranted, considering the natural advantages possessed by the United States in having at its command near great seaports so large a proportion of the world's

production of the crude product. Particularly for the development of American commercial interests in the Gulf of Mexico and on the Pacific coast would the work of such a commission have an important influence in extending its prestige and power, whether viewed from a commercial, maritime, or naval standpoint.
—*Engineering Magazine.*

The Smith Pneumatic Clutch Pulley.

A pneumatic clutch device or momentum absorber for relieving the shock on an electric motor or other means of power when starting under load has recently been patented by William R. Smith, 730 Ellicott square, Buffalo, N. Y. The device is placed in the interior of the shaft pulley, as shown in the halt-tone, Fig. 1. A detail of its construction is given in Fig. 2. The object of the device is to allow the shaft or pulley, as the case may be, according to which is the driven member, to get a slight start before the load is taken up. It is accomplished by having the shaft and pulley connected through cylinders and pistons instead of rigidly, so that each can move to a certain extent independently of the other.

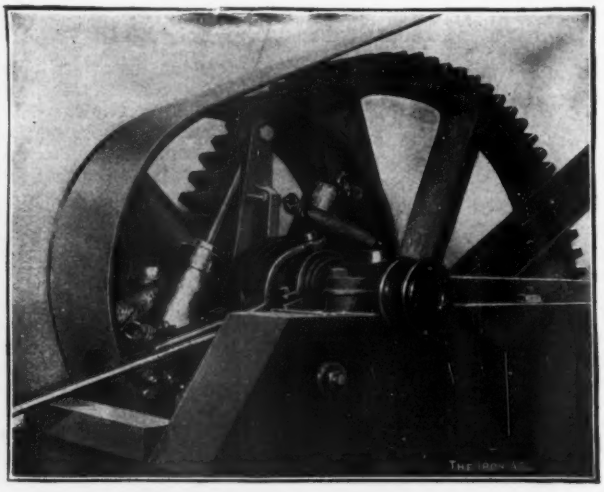


FIG. 1.—THE DEVICE AS IT APPEARS IN USE.

As shown in Fig. 2, the mechanism consists of two pulley arms or levers which are clamped to the shaft and connected at their outer ends to piston rods working in cylinders which are pivotally attached at their opposite ends to the rim of the pulley. When the motor is started the plungers are forced into the air cylinders, and the latter, being provided with small vents, cushion the application of the power, decreasing the jar of starting, and thus relieving the motor. It is stated that a pull of one pound on the lever arm in starting is sufficient to throw into operation a device of the largest size. After the strain is taken up the plungers are automatically returned to their initial position by means of springs connecting the levers with the rim in a manner to oppose the first starting movement. The sectional view at the right in Fig. 2 shows a positive clutch on the shaft which engages the hub of the levers to set the pulley in motion. The hubs of both the pulley and the levers are mounted loosely on a quill surrounding the driving shaft, and are prevented from being displaced endwise by means of collars fast to the shaft. The mechanism also has the effect of equalizing any sudden fluctuations in the

load or drive during continued operation.

When a motor is started in the ordinary manner much more power is required for the initial revolution to overcome the inertia of rest of the machinery than is required after it is up to normal speed. Where this device is used it is claimed that less power is required in starting, thus making it possible to use a smaller motor than would otherwise be necessary.

The vent in the air cylinder may be regulated so as to allow the motor to make one or more revolutions before the full load is taken up. The device is simple and inexpensive to construct and, as its parts are not likely to get out of order and there are no parts requiring oiling, it is cheap to maintain. Several of these clutches have been in operation for the past six months in the factory of the Buffalo Leather Company for driving large revolving washers and tannery wheels, and have demonstrated their utility in the saving of power. A field where the clutch should prove of value is in connection with the driving of heavy motor driven machines, such as reversible rolling mill tables, large planers, etc., or wherever quick starting of machinery causes serious sparking of the motor. It is suggested that its application to electric cars, in addition to reducing the sparking, would decrease the objectionable jerking of the car when starting. For the same reason it should increase the life of the gears. A company is now being formed, and a factory will be erected at Buffalo for the extensive manufacture of these clutches.—*The Iron Age.*

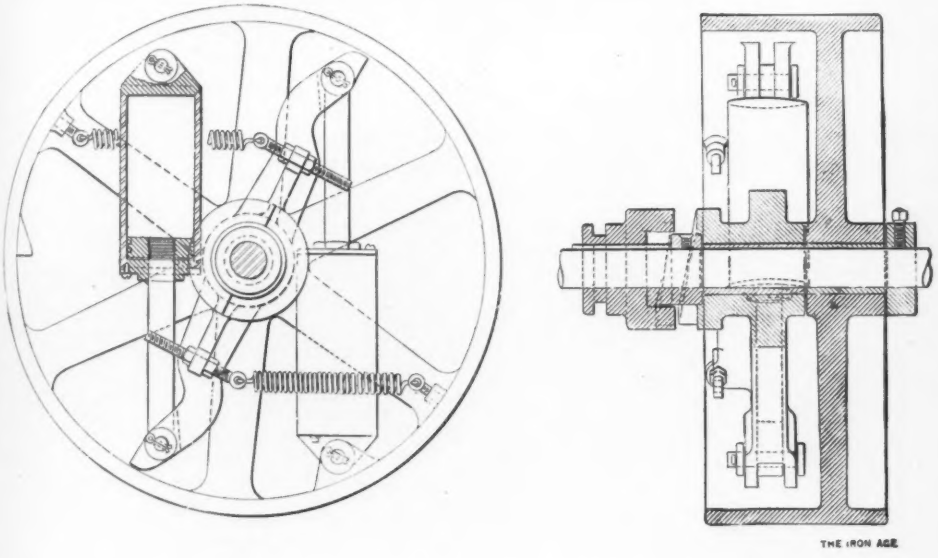


FIG. 2.—DETAIL OF THE SMITH CLUTCH PULLEY WITH PNEUMATIC MOMENTUM ABSORBER.

Heating of Compressed Air by Steam Injection.

The reheating of compressed air immediately before it is used has long been recognized as a possible means of very largely increasing the work which can be done by a certain amount of air. Theory and experience both show that there is no way in which heat can be transformed into work with so high an efficiency as by applying it to compressed air. To such

an extent is this true that numerous inventors have proposed to use this as a means of developing power, as it is possible to obtain more power in an engine run by highly heated air than was used in the compressor which supplied the air. This, of course, is not perpetual motion, but a system of transforming heat energy into power; in fact, the ordinary gas engine may be considered as a system of this kind in which one cylinder serves the double purpose of compressor and motor.

It is not, however, as a method of power development, but as a means of additional economy in transmission of power by compressed air that reheating is of greatest interest. Refinement in the production end of the compressed-air plant has reached a high degree of perfection, and it is at the utilization end that most of the future economy must be expected. For efficient results a temperature as high as practicable should be used, as the consumption of air depends directly upon the temperature at which it enters the machine.

Numerous plans of reheating have been adopted, many of which have been described in previous issues of COMPRESSED AIR. The method to be used in any place will depend largely upon local conditions, and it cannot be said off-hand that any particular system is best.

From the standpoint of fuel economy an internal combustion heater in which part of the air supports the combustion of the fire under pressure offers the greatest advantage, as all of the heat developed in the fuel is in this way added directly to the air and a high temperature of reheating can be obtained.

In many cases where air is used there is a supply of steam at hand, and when this is the case a very simple and effective method of heating the air is to turn steam into the air line near where the air is to be used. This does not, of course, give a very high reheat, but the heat which is added in this way is used very efficiently. This method has been used in several places, but there are no records of tests having been made to show the economy. For this reason the following test, made by Mr. A. W. Stone and the writer, may be of interest to readers of COMPRESSED AIR. The test was made on a 6-inch by 8-inch slide valve engine running at 200 R. P. M.

Runs were made at different temperatures of the mixture of air and steam. The results of some typical runs are tabulated below. The first run was made with air of the temperature at which it came from the air line. Owing to the freezing in the exhaust it was impossible to make more than a one-hour run when using cold air. In runs (2), (3) and (4) steam was turned into the air just before it entered the valve chest. The steam was passed through a separator before entering the air and a calorimeter attached to the supply showed perfectly dry steam. It will be noted that the temperature of the mixture in the valve chest does not correspond to the temperatures given in a steam table for the pressure in the chest. On mixing with the air a certain amount of the steam is condensed, and when the mixture is at a uniform temperature it consists of steam, air and hot water. The total pressure in the valve chest is due to the air and steam and equals the sum of the pressures which each of them would have if occupying the same space alone. For this reason the greatest temperature which can be obtained must be considerably less than that of the steam supplied.

The action inside of the cylinders is very complex. After cut off the air tends to drop very rapidly in temperature, but this is prevented by the steam which continues to condense and give up its heat to the air, thereby raising the expansion curve close to the isothermal. If too little steam is used freezing is sure to occur, as there is a large amount of moisture present. The table herewith shows the leading results of the tests, and it will be noted that a large saving in air follows the use of even a small amount of steam. The last item shows that in run No. 3 a horse-power was produced by seven and one-half pounds of steam when used in conjunction with air. This is better than has ever been attained in the best records of steam consumption in any steam engine and merely serves to illustrate the economic possibilities of steam if used with compressed air. In run No. 4 the percentage of steam to air was greater and the efficiency of the steam used began to fall off, but the amount used is still very small when compared with what a steam engine would use. For instance the same engine on which these tests were made has never given a horse-power for less than 50 pounds of steam when used as a steam engine.

The results of this test may be of value to those who have compressed air plants and also available steam of a higher pressure than the air pressure, so that it can be used for injecting into the air line as described.

RESULTS OF LIST.

Number of run	1	2	3	4
Length of run, hours	1	3	3	3
R. P. M. of compressor	121.7	96.2	80.73	67.72
R. P. M. of engine	197.45	200.16	200.3	199.77
Gauge pressure in valve chest	61.83	56.6	53.62	55.44
Temperature in valve chest	102.1	187.68	178.73	284.1
Temperature of exhaust air	(—)32	45.14	103.62	157.1
Steam pressure, gauge		103.15	104.84	109.06
Point of cut-off, per cent	45.65	45.65	45.65	45.65
Brake horsepower	5.5	5.575	5.58	5.56
Cubic feet of free air used per minute	68.5	57.2	28.3	26.2
Pounds of air per hour	808	277	165.5	127
Pounds of air per B. H. P. per hour	56	49.85	33.35	22.82
Per cent. of air per H. P. saved by heating	0	11	40.6	59.2
H. P. which would be developed by above amount of air if used cold under same conditions	5.5	4.945	3.312	2.267
Gain in B. H. P. by heating	0	10.7	16.92	42.2
Pounds of steam per hour per B. H. P. gained	0	17	7.45	12.8

C. A. DAWLEY, M. E.

Highest Development of Air Brakes—The High Speed Brake.

This country is impressed as it never has been before with the necessity for safeguarding lives and property in transportation, and its railroads are earnestly seeking means for meeting the problem of safety of trains. Among these is increased braking capacity, because the limiting conditions of safe speeds lies in the ability to stop quickly. Much is said about phenomenally high speeds of 100 miles per hour and over, but these will not be attained in regular service unless brake practice develops with the increased speeds.

For forty years of the early history of railroad progress the brake problem was not attacked. Up to 1864 no real improvement in braking was attempted. Since that year progress has been rapid, especially since the first use of the compressed air by Mr. Westinghouse, and now we have, in the "High-Speed Brake," the greatest development in this field and one which means more for the safety of fast trains than any other appliance now available.

At the St. Louis Exposition this brake is exhibited by the Westinghouse Air Brake Company, and the usual applications of apparatus with which all railroad men are familiar have given place to this apparatus, which was designed to meet the greatest present need.

The improved brake requires little apparatus in addition to that of the quick-action brake, and no change in the mechanism of the latter; but a train-line and auxiliary reservoir pressure of 110 pounds is employed instead of 70 pounds, the pressure generally used in connection with the quick-action brake. The high-speed brake consists of the quick-action air brake apparatus as ordinarily applied to a passenger car, to which is added an automatic reducing valve that is attached to the body of the car adjacent to the air cylinder, to which it is connected by means of a pipe. This reducing valve is so constructed that it remains inert in all service applications of the brake unless at any time the brake cylinder pressure becomes greater than 60 pounds, in which event the valve operates to discharge promptly from the brake cylinder as much air as is necessary to restrict the cylinder pressure to that intended. In an emergency application of the brakes the violent admission of a large volume of air to the brake cylinder raises the pressure more rapidly than it can be discharged through the port of the reducing valve, and the air is discharged from the brake cylinder in such a manner that it does not become reduced to 60 pounds until the speed of the train has been very materially checked. On emergency application, the high train

line and auxiliary pressures fill the brake cylinders almost instantly with air at about 85 pounds pressure, thereby giving a pressure of the brake shoes upon the wheels about 40 per cent. greater than that realized by the use of the quick-action brake alone. The air pressure immediately begins to escape from each brake cylinder through the automatic reducing valve, continuing to do so until the cylinder pressure is reduced to 60 pounds, which is thereafter maintained until the brakes are released by the engineer.

On account of the high pressure carried with this brake, a full service application of the brake will leave the pressure in the auxiliary reservoir at nearly 100 pounds; in fact, three full service applications can be made without recharging the auxiliary reservoirs, and there will still remain sufficient air pressure for an emergency stop equal to that of ordinary practice. These advantages, coupled with such a restricted brake cylinder pressure for all service applications of the brake that wheel sliding is avoided, require no further comments to insure recognition of their importance in materially advancing the art of train stopping.

The high speed equipment for a locomotive requires but few parts in addition to the quick-action apparatus and the simple movement of one or two cock handles to convert the brakes from quick action to high speed, or *vice versa*, thus making entirely practical the operation of either type, without delay or inconvenience. That the brake, with which over 24,500 locomotives and passenger cars have been equipped, has proven its utility as a positive and material advancement in air brake practice must be patent to all who visit the exhibit and familiarize themselves with its possibilities to accomplish results hitherto unattainable, and that its merits and value are rapidly becoming recognized by railways is apparent from the large number of locomotives and cars in daily service provided with the apparatus. To the layman the term "high speed" is to some extent a misnomer, for while the impression is conveyed that the brake is intended to be used only on trains scheduled at high continuous speeds, its meritorious features can be utilized to distinct advantage on all trains operating on a more moderate schedule, but frequently attaining speeds such as that for which the high-speed brake was primarily intended. The practicable solution of the important question of train control has been a prime factor in the establishment of fast passenger schedules, and the whole exhibit is an interesting example of the Westinghouse Air Brake Company's policy of harmonizing all of its improvements with its equipment already in service by simple and effective attachments to former standards.

In describing the "Schenectady Superheater Locomotive," savings of 33 per cent. were mentioned as having been effected by a superheater on the Canadian Pacific Railway. This record was made with a Schmidt superheater.—*American Engineer and Railroad Journal.*

Notes.

The A. S. Cameron Steam Pump Works has issued a miniature catalogue which is a reproduction in part of its recent complete catalogue. It contains some interesting material regarding pumps, while the different types of Cameron pumps are illustrated and described.

The Ingersoll-Sergeant Drill Co. has issued an attractive booklet entitled "Driving the New York Subway." This contains some interesting facts about that great engineering feat and incidentally calls attention to the fact that Ingersoll-Sergeant machinery played a very important part in making it possible.

The Chicago Pneumatic Tool Co. has received two gold medals for the highest awards covering its exhibit at the Louisiana Purchase Exposition, St. Louis. This company has been remarkably successful in securing awards at all exhibits, both foreign and domestic, since it has begun to display its products.

South Africa Mines, published at Johannesburg, contained in its issue of October 8th a strong criticism of the awards made by the Chamber of Mines for the best device for the prevention of miners' phthisis. The award, made to a drill which, the judges say they are unable to recommend for general use, is pointed out by the critic as a rather unusual proceeding.

A system of pneumatic tubes is now being installed to connect the office build-

ing to the General Electric Co. of Schenectady, N. Y., with many of the shops, thus supplying a means of quickly sending messages between the various offices and departments. Four miles of 4½-inch steel tubing will be included in the system. This is being installed by the Lamson Consolidated Store Service Co.

In the *Engineering Record* for November 5th there was an interesting description of the sewerage disposal works at Saltley, Eng. In this case a system of chemical treatment has been succeeded by the septic method. An important part of this system is the pumping of the sludge. A series of four Shone's pneumatic ejectors are connected with the sludge main. A pair of belt-driven air compressors supply the compressed air to operate these ejectors.

A recent English patented device is a compressed air apparatus for spraying oil and lead paints, or varnish and hot glue. It goes under the name of the "Pnumapant." Air is used at a pressure of 20 pounds to the square inch. It is similar in operation to a number of spraying machines which have already been on the market. A rather new feature are the different styles of nozzles which are supplied for it. An ordinary one is used for oil paint, a small one for decorative purposes or stenciling, a large nozzle for lime washing and white washing and a special one for tar.

Among the patents recently secured in England is one for a pneumatic power hammer granted to Wm. Graham. This invention relates to those in which both vacuum and pressure reservoirs are used, the object of the invention being to provide a hammer which may be controlled automatically. The hammer consists of a trunk divided into two chambers, one of which is maintained at a vacuum, and the other is supplied with compressed air. Each of the chambers is valve-controlled in accordance with the movements of a pneumatic motor adapted to place the top chamber in communication with the pressure and vacuum chambers as required to effect the various operations of the hammers.

Wm. Reavell and Reavell & Co., Ltd., of England, have recently secured the English patents for improvements to their air compressors. The invention consists of having in combination four cylinders radially arranged at equal distances apart in a hollow ring shaped frame; an air compressing piston in each cylinder; a crank shaft journalled and rotatable in two bearings, and having a crank pin at one end of the shaft; a connecting rod bearing at one end upon the crank pin, and adapted to transmit its motion to the piston of each of two oppositely placed cylinders; a yoke, forming a slotted cross head, connecting the pistons of the other two oppositely placed cylinders, having a sliding slipper, therein enclosing the crank pin adapted to transmit its motion to the said yoke connected pistons.

Another North river tunnel to connect Manhattan Island with New Jersey is the avowed purpose of a company formed by officials of the Lackawanna Railroad. Those who have visited the so-called Morton street tunnel, of which one line is already finished, may recall that its New Jersey shaft is in the backyard of the Lackawanna Railroad terminal at Hoboken. The owners of this tunnel have been fighting the railway for right of way for an approach under part of the Lackawanna property. In this legal struggle it was asserted by the railway counsel that their clients themselves proposed to tunnel under the North river, and their plans would be seriously obstructed were another tunnel permitted under their property. The incorporation of the company last week is generally understood to be more a step in the struggle for right of way underground than a promise of early work on another tunnel.—*Engineering Record.*

"Mechanical Appliances, Mechanical Movements and Novelties of Construction" is the title of a valuable work by Gardner D. Hiscox, which has just been published by the Norman W. Henley Publishing Co., of New York. While the work is complete in itself it comes as a second volume of the author's work, "Mechanical Movements, Powers and Devices." The ten editions through which the first volume of "Mechanical Movements" has passed is more than a sufficient encouragement to warrant the publication of this second volume, which is more special in its scope than the first,

inasmuch as it deals with the particular requirements of various arts and manufactures, and more detailed in its explanations because of the greater complexity of the machinery selected for illustration. Readers of COMPRESSED AIR will find it an interesting book, and one section on air power motors and appliances will particularly appeal to them.

The use of electric brakes in hoisting is open to the objection that whether they are connected in series or in parallel, their action is not sufficiently powerful and sudden to stop the motor directly they are applied. M. Jordan has just invented a system in which compressed air is used to increase the power of an electrically driven hoisting apparatus. The brake comes into action the moment the piston of a brake-cylinder communicating with a compressed air reservoir is driven forward under air pressure. An electro-magnet actuates a device which brings the cylinder in communication with the reservoir or the atmosphere, the brake being on in the first case and off in the second. This electro-magnet is itself operated by the motor-starting device, but a small switch can sever this connection. One of the advantages of this system is that the electro-magnet is of very small dimensions, as instead of having to supply the total breaking power, its function is merely to open a small valve.—*The Electrical Magazine* (Eng.).

An automatic window operated by compressed air has made its appearance. A small pump, ordinary piping, two cylinders and two valves comprise all the machinery necessary to accomplish the desired result. The air is supplied by a simple and inexpensive arrangement of an ordinary water motor. The quantity of water used is said to be so small as to be scarcely perceptible in the bills for water rent. The air pump is located beside the water motor and works noiselessly. It requires no attention and, it is claimed, cannot get out of order. Small lead or iron pipes conduct the air to the various windows. The turning of a knob or the pushing of a button permits the window to either open or close without any effort on the part of the operator. This system can also be adapted to sliding doors. Another device is an automatic burglar alarm attached to the air line, with alarm whistles located throughout the building. If anybody tampers with the window or disables the locking device these whistles immediately give the alarm. This device is manufactured by the Hood Automatic Window Co., St. Nicholas Building, Pittsburg.

The Acme Water Storage and Construction Co. exhibited at the St. Louis Exposition apparatus intended to make possible the constant supply of water under high pressure for tall buildings, country residences and small municipal water works, displacing water towers or elevated water tanks. The system involves the use of two air-tight tanks, a pump and an air compressor. One tank is kept constantly charged with air at a high pressure, while the other contains both air and water, the air being admitted to the second tank from the first by a pressure-reducing valve set to give constant pressure in the second tank, and the water being forced into the tank by a pump. The entire contents of the water tank may be used under a constant pressure, without operating either the compressor or pump, and it is necessary to run the latter only at such times as are found convenient for charging the system. As the water is pumped into the water tank, the air is removed by the compressor and returned to the air tank, so that the water pump always operates against a uniform pressure.

The apparatus exhibited includes two tanks, each five feet in diameter and ten feet long, and an air compressor and a pump operated by a single five horse-power gas engine. The pump is of the Deane vertical, triplex, geared type, and is filled with 4-inch cylinders, the plungers in which have a stroke of six inches. These pumps are designed for a pressure of 100 pounds per square inch and a speed of 47.3 revolutions per minute, the speed of the gas engine being 280 revolutions.

In this section of an article discussing braking of electric cars, Mr. E. H. Dewson describes the straight air-brake equipment as frequently used. In this system the reservoir should be large enough to operate the brake three or four times without the pressure falling more than twelve or fifteen pounds. The air from the reservoir is supplied directly to the brake cylinder through a valve. The pressure in the

reservoir is kept approximately constant by an automatic governor, which controls the small motor-driven compressor. The governor ordinarily starts the compressor if the pressure falls to fifty pounds. It stops it when the pressure in the reservoir has reached sixty-five pounds. When installing the system it is important to place a switch in the compressor motor circuit at each platform, so that the motor may be stopped if the governor fails to work. When whistles, pneumatic sanders and other devices operated by compressed air are to be used, these must be considered when deciding upon the size of compressor and reservoir. Frequently it is found that the whistles alone use as much air as is required by the brakes. The advantage of the straight air brake lies in its directness and simplicity and in the fact that it requires less skill to make an exact stop than with an automatic air brake. Its greatest disadvantage is due to the fact that, in the event of a break in the piping or in the hose connections between the cars (if operated on a train), the motorman is left with nothing but the handbrake on which to depend. Another disadvantage, which is apparent in operating in trains, is that the brakes of the different cars do not act simultaneously, due to the frictional resistance of the train pipe. This causes a disagreeable, and often dangerous, bumping and jerking of the cars. *Abstracted by the Electrical Review from the Electric Club Journal (Pittsburg), October.*

In a paper entitled "Some Operating Experiences in High Tension Transmission," which was read before the Association of Edison Illuminating Companies, at Newcastle, N. H., by D. L. Huntington, reference was made to the value of compressed air. He says:

"Considerable difficulty has been encountered in preventing the accumulation of sediment on the interior of cooling coils even when the water is apparently very clear. This sediment is in no respect similar to boiler scale and is probably not caused in any material degree by the heat of the transformer.

"We have in all cases two sources of water supply for cooling, one of which is generally under high pressure (300 to 400 feet head). It was at first thought that this water, with high velocity, would effectively clean out any sediment which might be deposited in the coils. Such was found not to be the case, and other means were sought. Recourse was had to compressed air, which is, fortunately, available at all our sub-stations. This mixture of air and water is much more effective. The water is shut off and compressed air is forced through the water in the coils under about 60 pounds pressure. This violently agitates the water; upon turning on the water supply the water leaves the coils in a very muddy condition for a brief period. In one case this is done daily; in another every other day. The high-pressure water is run through all coils daily. In the worst case we can note an appreciable rise of temperature after two days. It is noteworthy that the water in this case is from a spring and is apparently perfectly clear.

"Similar trouble has been experienced with the cooling jackets of air compressors, but there the sediment forms quite hard scales and resembles boiler scale more closely, probably, being acted upon in such cases by heat."

The council of the Institution of Mining and Metallurgy have issued a memorandum calling the special attention of members to the serious nature of the statistics dealt with in the paper by Dr. J. S. Haldane, F.R.S., and Mr. R. Arthur Thomas, on "The Causes and Prevention of Miners' Phthisis." The council are anxious to secure the co-operation of the members of the institution in the immediate adoption of effective methods of prevention, and in collecting further information as to the prevalence of the disease and the conditions which give rise to it. There can now be little doubt that the main cause of this disease is the breathing of air containing stonedust in suspension. The council therefore strongly urge upon members of the institution the necessity of taking all practicable measures for keeping the air of mines free from dust, and preventing work being performed in places where dust is temporarily present in the air, as after blasting. They recommend in particular that in rock drilling water should be used in such a way that no dust escapes into the air at any part of the operation, whether the hole be bored upwards or downwards; that the dust, after blasting, be either drowned by water, removed by ventilation, or allowed to subside before the men return, and that, as

far as possible, the rock broken be damped before removal. The council are taking steps to secure the co-operation of other technical societies in the collection of information, and they hope that members will assist by collecting and forwarding to the institution authentic information on the following points: (1) Frequency or infrequency of the disease in connection with different kinds of mining work and different varieties of rock; (2) nature and amount of the stonedust present in the air, in different varieties of mining work; (3) nature, amount and effect on miners of the gaseous impurities met with in the air of metalliferous mines—in particular, poisonous impurities arising from blasting, etc.; (4) means in actual use for preventing the formation and inhalation of dust or poisonous gases; (5) evidence as to efficacy and practicability, or otherwise, of these means.—*Colliery Guardian* (Eng.).

The *Machinery Market*, an English publication, contains a description and illustration of a portable air compressor which has recently been placed on the market by Davey, Paxman & Co., Limited, of Colchester, England. The description follows:

"The air compressor consists of a block piston, with bronze rings, sliding in a cast-iron cylinder. The covers of this cylinder, both back and front, carry the suction-valves, which, in turn, are covered by a very fine wire gauze cap, visible on the engraving immediately above the boiler fire-box. The air delivery-valves are situated above the cylinder. The cylinder is cast in one with its jacket, a rectangular-shaped box, through which cold water is circulated, entering the bottom and overflowing at the top down a pipe to the cooling tank. The circulation of water is kept up by a plunger pump, fixed in a similar manner to a feed pump, to the boiler, and operated by an eccentric on the crank shaft.

"The engine has a single cylinder fitted with automatic expansion gear. It is self-contained on its own bed-plate of steel plate, which is carried on brackets bolted to the boiler shell. The stresses between the steam-cylinder and air-compressor are transmitted direct from one to the other through this steel-plate framing on one side and a tie-bar on the other side.

"The apparatus has all moving parts cased in, as a protection against dust, by a light sheet steel casing. The casing has well-fitting inspection doors at all points requiring the periodical attention of the driver while running, and the whole is easily removed when required.

"On each side of the air-compressor there are large air receivers, carried on brackets, and which carry a number of valves, from which pipes may be led to the various tools or motors in use.

"The rated capacity of the plant is 60 cubic feet of free air per minute, delivered at 100 pounds per square inch pressure. All dimensions are ample for the rated capacity, and we understand that, as a matter of fact, the plant showed on test a capacity of 66 cubic feet of free air per minute, compressed to 110 pounds pressure, and has since been worked at an output of 73½ cubic feet per minute to this latter pressure."

An event of importance will be the fiftieth meeting of the American Society of Mechanical Engineers, at New York, December 6 to 9.

The headquarters of the Society will be as usual at the Society house, 12 West Thirty-first street. The opening session will take place on Tuesday evening, December 6, at 9 o'clock. President Ambrose Swasey will deliver the annual address, the subject being on the "Achievements of the Engineer with Respect to Exact Measurements."

The second session comes on Wednesday morning at the hall of Mendelssohn Union, 113 West Fortieth street, at 9.30 o'clock. This will be the business session of the convention and the following professional papers will also be presented: "A New Hydraulic Experiment," by Mr. A. F. Nagle; "A Twist Drill Dynamometer," by W. W. Bird and H. P. Fairfield; "Diamond Tools," by Gus C. Henning. Following this luncheon will be served at the Society house, and the afternoon will probably be spent in making excursions to various power stations and points of interest. The evening of this day has been left free for the members to make their own engagements.

The third and fourth sessions will take place at Mendelssohn Union, Thursday morning and afternoon, respectively. At the morning session the following professional papers will be considered: A. J.

Bowie, Jr., "Centrifugal Fans"; Charles T. Main, "Computation of Values of Water Powers and Damages Caused by Diversion of Water Used for Power"; Chas. E. Sargent, "An Indicating Steam Meter"; Robert S. Hale, "Stay Bolts, Braces and Flat Surfaces; Rules and Formulae"; George I. Rockwood, "Condensers for Steam Turbines." At the afternoon session the professional papers will be as follows: "Bursting of Four-Foot Fly-Wheels," by Charles H. Benjamin; "Influence of the Connecting Rod Upon Engine Forces," by Sanford A. Moss; "Losses in Non-Condensing Engines," by James B. Stanwood; "Power Plant of Tall Office Buildings," by Stirling H. Bunnell; "Pressures and Temperatures in Free Expansion," by A. Bordody and R. C. Cairncross (presented by Charles E. Lucke). Between the morning and afternoon sessions luncheon will be served at the Society house. The usual reception for guests and friends will be held at Sherry's on Thursday evening at 9 o'clock, and will be followed by dancing and supper.

The closing session will be held at the Society house on Friday morning, December 9, at 10 o'clock. Following are the professional papers that will be considered: "Fuel Consumption of Locomotives," by George R. Henderson; "Road Tests of Brooks Passenger Locomotives," by E. A. Hitchcock; "Discharge of Water with Steam from Water-Tube Boilers," by A. Bement; "More Exact Method for Determining the Efficiency of Steam Generating Apparatus," by A. Bement; "Forcing Capacity of Fire Tube Boilers," by Francis W. Dean.

The Science and Art of Mining, an English publication, publishes in each issue a series of questions on mining and awards prizes for the best replies. In a recent issue it asks:

"In using compressed air underground it has been frequently found that ice clogs the exhaust pipe. How is this and what can be done to mitigate the evil?"

It is interesting to note how H. Batton, of Cramlington, Northumberland, solves the problem which has troubled so many users of compressed air. He says:

"Mining has been one of the most active means of giving prominence to compressed air. In these days of active competition and imperative demand for decreased cost of production, greater economies and improved appliances for cheapening the mining of coal have been absolutely essential to profitable mining. New fields, as soon as developed, have established at once the necessity of installing at once the most approved machinery for pumping, mining and haulage; and for such, in spite of the low useful effect caused by loss of heat and increased friction, compressed air is greatly favored. The reason lies in its comparative safety, and the many ways in which it can be used.

"In using compressed air we cannot afford to use the air without expansion, hence some means must be adopted to use the air expansively without being encumbered with the freezing difficulty. Several methods have been devised of heating the air before it reaches the motor, so as to obtain the necessary expansion and avoid freezing.

"When the compressed air comes to be used to drive an engine, the air has already cooled down nearly to its former temperature. When it is expanded in the cylinder down to the atmospheric pressure, its temperature falls very low, and thus its pressure upon the piston falls much more rapidly than it would do if the temperature remained constant. When the air is exhausted its temperature is usually much below the freezing temperature of water, and therefore the mixture in the air is frozen upon the exhaust valves, and causes them much trouble by choking them with ice.

"In my opinion the best means to adopt to diminish the loss from this cause would be to provide air receivers of a large size both near the air compressor on the surface and near the engines underground when the air is used; these, together with air mains of ample dimensions, would give sufficient time to deposit any moisture held in suspension, and with large and straight exhaust passages no trouble need be experienced from ice, because if there is no moisture or water it is not likely there will be ice.

"As before stated, reheating the air is another method adopted to prevent the formation of ice. This is done by passing the ice near the motor through a coil of pipes heated by a small furnace; and a further elaboration, permitting the highest degree of expansion, is effected by introducing a small quantity of water into

the heater, where it is converted into steam.

"In practice it is found that reheating the air not only prevents freezing, but results in a very great economy in the use of compressed air, at a small cost for both plant and fuel."

Among the patents recently accepted in England is one for a compressed air drill. The patentee was L. Thomas, of Ans-lez-Liége, Belgium. This invention is for a rotary drill driven by compressed air. It is especially distinguished by the fact that the feed and rotation of the drill spindle are two movements, entirely independent from each other; the former being produced by hand with the aid of a crank and the latter by a continuous rotary motor.

The motor comprises a cylinder, furnished at one end with a socket serving as guide, simultaneously with a socket upon the cover at the opposite end of the cylinder, to the hub of an inner body, provided with the clacks upon which the compressed air acts. The socket upon the cylinder is provided with the pivots by means whereof the appliance is placed in a holder, and it is surmounted by another socket into which lead, on the one hand, the conduits by which admission of air takes place in the cylinder, and, on the other hand, the tube coming from an inlet regulator for this air. The inlet conduit leads into the cylinder, beneath the distributors fixed inside the cylinder and provided with a longitudinal opening for the passage of compressed air. The outlet of expanded air takes place by openings arranged in the walls of the cylinder, immediately in front of the distributors.

The inner body of the pulley is provided between two flanges, one fixed and the other removable, with oscillating clacks, made preferably integral with the pivots, one of the ends whereof, which passes through the removable flange, is furnished with levers. The cylinder cover is formed, preferably by a cross piece, fixed by its ends to the cylinder and furnished laterally with two lids, whereby the pulley and clacks can be examined and easily lubricated. Inside the cross piece are also arranged stops against which the clack levers hit when lifted up. The distributors are provided upon the inside with a projecting part, projecting against the body of the pulley, the tightness between these two parts, as well as that between the flanges of the pulley and the cylinder walls, is obtained by means of angle-shaped leathers. To allow their passage, the distributors are furnished at their bases with grooves. The clacks are also provided with similar leathers, preventing any escape along the cylinder walls. Stops fixed upon the outer side of the removable flange serve as bearing points to the clack levers when these levers are lowered and prevent an excessive friction of the clacks upon the cylinder, the tightness of the joint being perfectly assured by the leather.

The drill stock is furnished with a longitudinal mortise passing through the hollow hub of the pulley and is guided longitudinally therein by a feather engaging in the mortise. One end of this shaft is provided with a tapered hole for the drill, whilst at its other end it is hollow. A screw enters into the hollow of the shaft by passing through a nut, partly screw-threaded, and one part, that not screw-threaded, surrounds the end of the drill holder, freely assembled to the shaft by means of two rows of ball bearings placed in circular grooves arranged respectively upon the outer wall of the hollow shaft and in the inner wall of the hollow shaft of the cylindrical part of the nut. A cylindrical portion of the screw is placed in a frame fixed to the cylinder by means of two flanges, whilst the square end of the screw receives a cranked handle. An appropriate ring prevents the nut from withdrawing when rotated.

In another form, the inlet conduits lead into the cylinder by ports, in front of separators, fixed to the inside of the cylinder, and the inner part whereof makes a joint with the body of the pulley, the escape of expanded air to the outside takes place through openings in the walls of the cylinder behind the separators. The inner portion of the pulley is provided with two fitted flanges, in which enter pivots of the clacks and levers oscillating by clacks.

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U.S. PATENTS GRANTED OCT., 1904.

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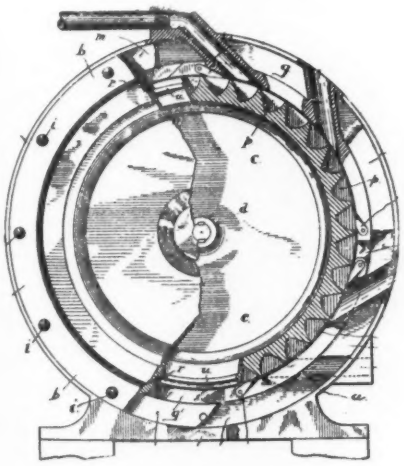
771,296. PROTECTOR FOR PNEUMATIC TIRES. James F. Burnam, Madison Station, Ala. Filed Feb. 20, 1904. Serial No. 194,509.

771,599. PNEUMATIC POWER-WHEEL. Arthur C. Bates, Oakland, Cal. Filed Dec. 11, 1903. Serial No. 184,824.



A pneumatic and water-power wheel or motor comprising a circular case, a wheel revolving in said case, said wheel having equidistant buckets on the periphery thereof, the walls of said buckets being adapted to contact with packing in the interior of said case, and said case having recesses arranged within such interior to contain packing for contact with said wheel to prevent the escape of fluid, inlets for the discharge of fluid against the walls of said buckets, and said case having ports for the escape of fluid from said buckets to the exterior of said case, ports for the escape of fluid into the chamber of said case and ports for the entrance and escape of fluid to and from such chamber, substantially as and for the purposes described.

771,634. FLUID-PRESSURE BRAKE SYSTEM. Maury W. Hibbard, Chicago, Ill., assignor to Richard Fitzgerald, Chicago, Ill. Filed Mar. 13, 1903. Serial No. 147,593.

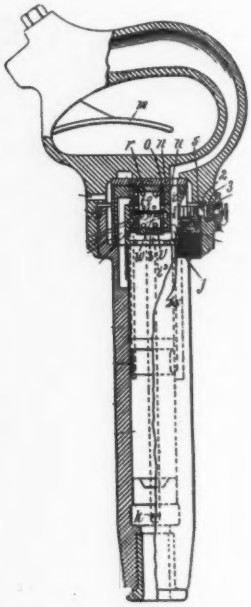
771,674. FASTENING DEVICE FOR PNEUMATIC TIRES. Thomas Sloper, Devizes, England, assignor to Christian Hamilton Gray, Silvertown, Essex county, England. Filed Mar. 12, 1904. Serial No. 197,867.

771,813. CAPSULE FOR HOLDING COMPRESSED GAS. Samuel H. Crocker, London, England. Filed Apr. 3, 1903. Serial No. 150,960.

771,857. PNEUMATIC GOLD-SEPARATOR. William Broadbent, Salt Lake City, Utah. Filed Jan. 23, 1904. Serial No. 190,412.

The combination with the tank of two side casings with feed-openings therein, a depression provided with an opening and closure therefor in the bottom of each side casing, a shaft extending through the side casings and tank carrying adjustable conveyer-blades within the side casings, sprocket-wheels on said shaft for driving it from a second shaft, and carrying perforated buckets, and means for delivering short puffs of air within the side openings near the bottom of the depressions.

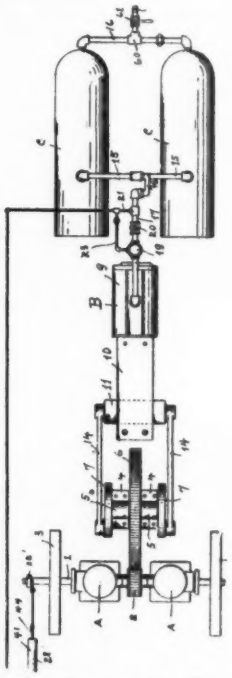
771,554. PNEUMATIC HAMMER. William L. Ketchen and Harry F. Adams, Montreal, Canada. Filed Oct. 8, 1903. Serial No. 176,250.



A tubular valve for the purpose set forth, having both ends closed and presenting flat surfaces at right angles to the axis of the valve, a shoulder upon the perimeter of said valve between its ends, the portion of such valve between the shoulder and one end being perforated and the portion thereof between the shoulder and the opposite end having a port therein, and means preventing the passage of a motive fluid from the first-mentioned perforations to the last-mentioned port.

A pneumatic hammer comprising a barrel, and a handle portion, the handle portion being formed with an interiorly-screw-threaded sleeve, and the barrel being formed at one end with an exteriorly-screw-threaded annular flange adapted to be threaded into said interiorly-screw-threaded sleeve, the combination with said sleeve and barrel, of a nut of tubular form and threaded into an opening in said sleeve in line with the inner end of the barrel, and having a circumferential flange upon its outer end adapted to be jammed upon the edge of the opening, said opening extending completely through said sleeve, an annular series of ratchet-teeth formed upon the exterior of the extremity of said screw-threaded flange of the barrel, a spring-pawl carried within said tubular nut and adapted to engage said ratchet-teeth, means for disengaging said pawl from said ratchet-teeth.

771,789. PNEUMATIC POWER SYSTEM. William F. Moughler, Toledo, Ohio. Filed Aug. 24, 1903. Serial No. 170,540.



A pneumatic power system, the combination with a gas-engine, an air-compressor, and a receiver, so connected that the engine operates the compressor to maintain a pressure of air in the receiver, of an adjustable circuit-breaker for the engine adapted to be adjusted to cause ignition of different charges at different points in the travel of the piston and at different degrees of compression and thereby increase or diminish the power and speed of the engine, a regulator for the circuit for the circuit-breaker, comprising a cylinder, a piston in the cylinder, a helical spring in the cylinder engaging one end of the piston and one end of the cylinder, and normally resisting the movement of the piston toward the spring, a pipe connecting the cylinder with the receiver, means connecting the piston with the circuit-breaker adapted to shift the point of contact of the circuit-breaker to reduce

the power and speed of the engine proportionately to the movement of the piston against the resistance of the spring, and to increase the power and speed of the engine proportionately to the movement of the piston by the spring against the resistance of the air in the cylinder, substantially as set forth.

771,874. PNEUMATIC HYDRAULIC SEPARATOR. William R. Grant, Denver, Colo., assignor to The Colorado Iron Works Company, Denver, Colo. Filed Mar. 19, 1903. Serial No. 148,617.

An apparatus for separating and classifying material comprising a casing for holding a liquid and having an outlet at its top for fine material and a lower outlet for the coarser material and means for introducing air to rise upwardly in the said casing, said air-introducing means being interposed axially between the upper and lower outlets and at an intermediate height in said casing and diffusing air throughout the entire cross-sectional area of the said casing and leaving passages throughout the cross-sectional area for the free fall therethrough of the coarser material, substantially as described.

772,124. AIR-BLAST GRAIN-SPOUT. Charles G. Benedict and William Anders, Creighton, Nebr. Filed Feb. 5, 1904. Serial No. 192,093.

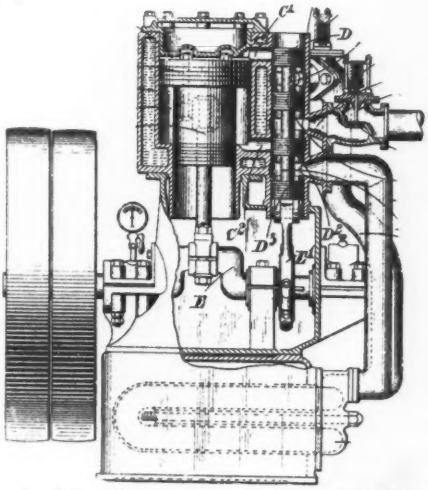
772,167. PRESSURE-RETAINING MECHANISM FOR FLUID-PRESSURE BRAKES. Frederick Mertsheimer, Denver, Colo. Filed Jan. 22, 1904. Serial No. 190,184.

772,227. AIR-BRAKE ATTACHMENT. Daniel M. Elder, Eldorado, Kans. Filed Jan. 25, 1904. Serial No. 190,559.

772,347. AIR-MOISTENING APPARATUS. Quimby N. Evans, New York, N. Y. Filed Dec. 11, 1903. Serial No. 184,845.

An air-moistening apparatus, in combination, a vertical tubular casing open at its opposite ends for free ingress and egress of air, a basin beneath its bottom with a space between for free lateral discharge of air, and with means for retaining a quantity of water in said basin, a fan within said casing rotating on a vertical axis and having oblique blades for producing a directly-downward current of air therethrough, said fan serving primarily to determine the volume of air passed through the apparatus and the area or room moistened thereby, a water-wheel arranged to drive said fan and to discharge into said basin, and a moistening device in said casing comprising a spraying-nozzle producing a fine spray which is distributed with the downward current of air and any precipitation from which is caught in said basin, said spray serving primarily to determine the quantity of moisture or degree of humidification in the current passing through the apparatus.

772,266. AIR-COMPRESSOR. Stephen E. Alley, Glasgow, Scotland. Filed Jan 27, 1904. Serial No. 190,877.



A "stage" gas-compressor the combination of a differential trunk reciprocating piston, a cylinder divided by it into two compression-chambers, an inlet-conduit and an exhaust-conduit both terminating in one of the two compression-chambers, a sliding valve adapted to open and close both conduits, a valve-operating mechanism by which that sliding valve is given simple harmonic motion across the conduits, a fluid-operated valve controlling the exhaust-conduit and situated at a point therein which is farther from the cylinder than is the sliding valve, means for exerting pressure upon the fluid-operated valve sufficient to normally close the exhaust-conduit and so proportioned as to apply to the valve a thrust greater than that which immediately that the sliding valve opens the exhaust-conduit is exerted upon it in such a direction as to tend to open it by the air in compression in that portion of the exhaust-conduit which is between the loaded fluid-operated valve and the piston.

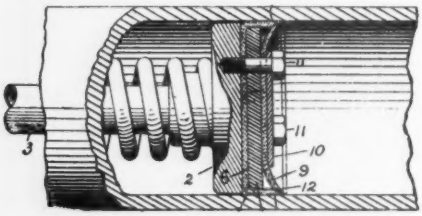
772,387. APPARATUS FOR TEMPERING AIR. John Titus, Oyster Bay, and William Titus, Old Westbury, N. Y. Filed Aug. 20, 1902. Serial No. 120,294.

The combination with a chest for holding refrigerating material, and an air-conducting pipe within said chest constructed and arranged

for the removal of water of condensation therefrom, of a heating apparatus connected with the exit end of the said pipe, a valve in said pipe whereby its communication with the heating apparatus may be shut off, a separate pipe extended from the heating apparatus to the air-pipe at a point in the latter remote from its refrigerated parts, and a valve in said separate pipe whereby communication may be opened from the blower direct to the heating apparatus, while passage through the refrigerated air-pipe is closed, as described.

772,404. FLUID-PRESSURE BRAKE APPARATUS. Murray Corrington, New York, N. Y. Filed Aug. 11, 1904. Serial No. 220,342.

772,457. HYDROSTATIC OR PNEUMATIC PISTON. John H. Cramer, Lancaster, Pa., assignor to John E. Reyburn, Philadelphia, Pa. Filed Jan. 23, 1904. Serial No. 190,261.



A piston, a head and a rod, a cup-disk packing having a deep flange, an interior bevel on the flange edge, a follower fitting under the flange for a portion of its depth, a pressure-disk lying upon the follower for a portion of its diameter and exterior to which it is turned outward with its edge under the outer edge of the cup-flange, a plate covering its central portion, and means to secure the plate, the pressure-disk, the follower and the cup-disk to the piston-head.

772,539. AUTOMATIC COUPLING FOR AIR BRAKES. Franklin A. Shively, Braddock, Pa. Filed Mar. 30, 1904. Serial No. 200,750.

772,702. AUTOMATIC AIR-BRAKE. William E. Delancy, Adams, Mass. Filed Feb. 5, 1904. Serial No. 192,134.

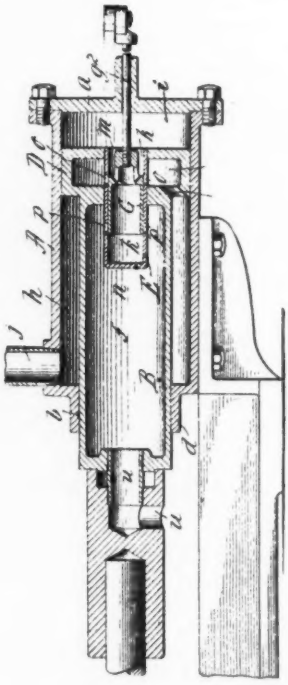
772,765. AIR-VALVE. Thomas Wheatley, Syracuse, N. Y. Filed Apr. 1, 1902. Serial No. 100,982.

772,771. PNEUMATIC LEAF-TURNER. Jeremiah W. Albin, Babylon, and Lois A. Seaman, Mineola, N. Y. Filed May 31, 1904. Serial No. 210,449.

772,817. PNEUMATIC-STACKER ATTACHMENT. George T. Nicoson, Hoopeston, Ill. Filed June 20, 1903. Serial No. 162,350.

772,952. ANGLE-COCK FOR PRESSURE BRAKE SYSTEMS. Frank B. Morrison, Toledo, Ohio, assignor, by mesne assignments, to The Morrison Automatic Safety Valve Company, Toledo, Ohio, a Corporation of Arizona. Filed Aug. 15, 1902. Serial No. 119,770.

773,365. FLUID-PRESSURE MOTOR. Charles H. Atkins, Springfield, Mass. Filed Mar. 3, 1904. Serial No. 196,341.



A fluid-pressure motor, in combination, a cylinder having at one end a head, and at the other a contracted opening, and provided with a pressure inlet-opening, a differential plunger slidable through said contracted opening, and having a hollow piston-head, fitting in the cylinder, and provided with a port, establishing communication between the cylinder-chamber and the chamber in the hollow piston-head, a valve-chamber within said piston-head of the plunger, opening endwise to the cylinder-chamber, and having a port opening to the chamber in the piston-head, and a cut-off valve endwise movable in said valve-chamber.

772,951. AUTOMATIC AIR SAFETY-VALVE. Frank B. Morrison, Toledo, Ohio, assignor, by mesne assignments, to The Morrison Automatic Safety Valve Company, Toledo, Ohio, a Corporation of Arizona. Filed Jan. 8, 1902. Serial No. 88,902.

772,953. COMBINED ANGLE-COCK AND SAFETY-VALVE. Frank B. Morrison, Toledo, Ohio, assignor, by mesne assignments, to The Morrison Automatic Safety Valve Company, Toledo, Ohio, a Corporation of Arizona. Filed Feb. 26, 1903. Serial No. 145,117.

772,970. BUOYANCY-REGULATING APPARATUS FOR SUBMARINE BOATS. Lawrence Y. Spear, Greenport, N. Y., assignor to Electric Boat Company, New York, N. Y., a Corporation of New Jersey. Filed Nov. 12, 1903. Serial No. 180,811.

772,973. PNEUMATIC-DISPATCH APPARATUS. Charles F. Stoddard, Boston, Mass., assignor to American Pneumatic Service Company, Dover Del., a Corporation of Delaware. Filed Jan. 9, 1904. Serial No. 188,378.

773,216. PEUMATIC TIRE. Madeleine M. Mills, New York, N. Y. Filed Feb. 1904. Serial No. 192,772.

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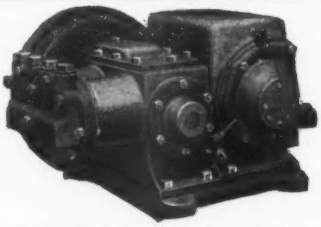

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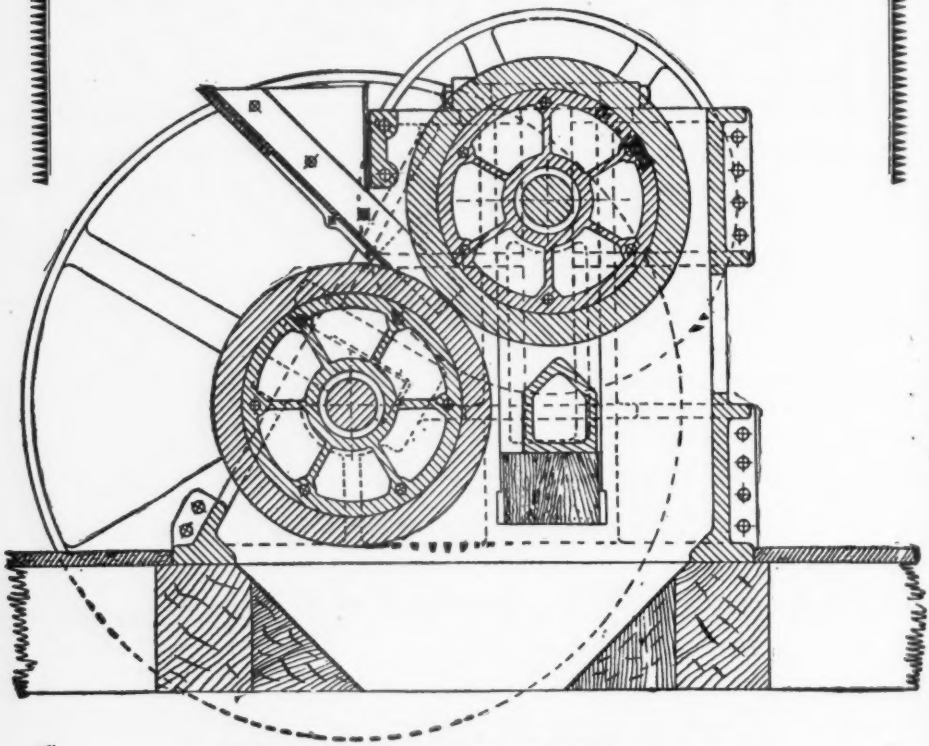

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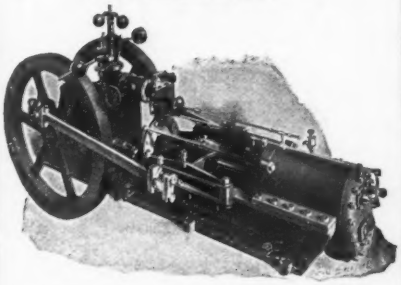

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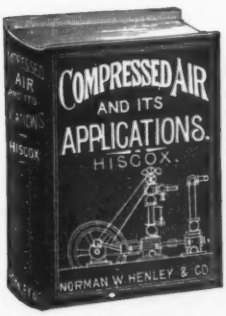

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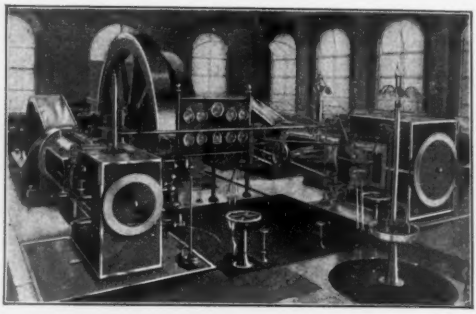

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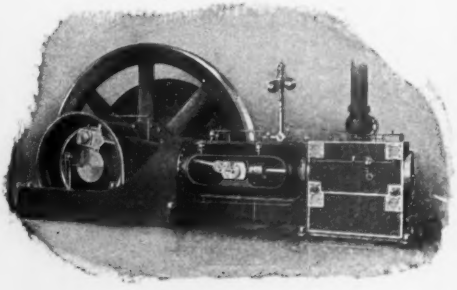

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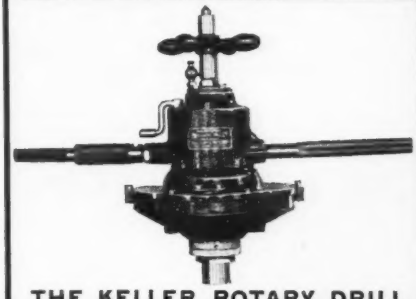

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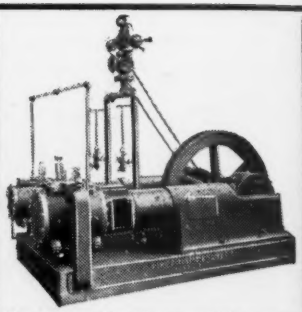

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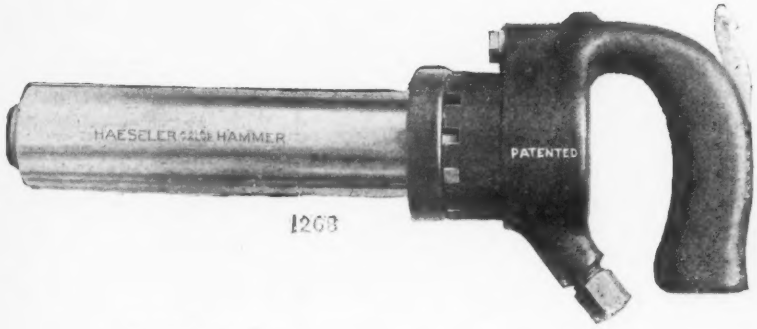

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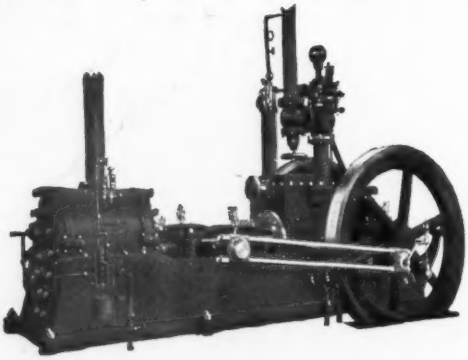

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